UNCLASSIFIED

AD NUMBER

AD907010

NEW LIMITATION CHANGE

TO

Approved for public release, distribution unlimited

FROM

Distribution authorized to U.S. Gov't. agencies only; Test and Evaluation; DEC 1972. Other requests shall be referred to Naval Civil Engineering Lab., Port Hueneme, CA 93043.

AUTHORITY

USNCEL ltr, 1 Oct 1973

THIS PAGE IS UNCLASSIFIED

Technical Note N-1258

OSDOC II ENGINEERING TESTS - CORONADO

By

R. C. Towne, J. J. Traffalis, D. A. Davis, D. B. Jones, B. R. Karrh,
H. S. Zwibel

December 1972

NAVAL CIVIL ENGINEERING LABORATORY
Port Hueneme, California 93043

OSDOC II ENGINEERING TESTS - CORONADO

Technical Note N-1258

YF 38.536.005.01.010

by

R. C. Towne, J. J. Traffalis, D. A. Davis, D. B. Jones, B. R. Karrh, and H. S. Zwibel

ABSTRACT

The Coronado engineering tests were conducted for purposes of evaluating the equipment capabilities and limitations of the NCEL concept. This concept evaluation included off loading 8'x8'x20' containers from a simulated non-self-sustaining containership and transporting the containers ship-to-shore in a roll-off mode via a pontoon causeway ferry shuttle, and across hardened beaches to a stabilized storage area. Available inventory equipment and techniques were used in these tests, such as a Navy floating YD-type crane, standard NL pontoons, Marine Corps truck/trailers, and Mo-Mat and On-Fast beach hardening. The tests were conducted in two phases: first, in the San Diego Harbor to familiarize the operators with the concept and procedures and second, in the open sea to evaluate the equipment concept. The results of the evaluation demonstrated the feasibility of the concept and the ability of the available inventory equipments to off load containers from ship-to-shore in wave/swell conditions in excess of original estimates for these equipments. Also apparent was the ability of the equipment operators to perform the concept functions with a minimum of special training and guidance beyond their normal training. The concept of a floating crane/causeway ferry shuttle is recommended for the joint service OSDOC II exercise.

TABLE OF CONTENTS

BACKGROUND

The Department of the Army conducted an Offshore Discharge of Containerships (OSDOC I) exercise in 1970 to demonstrate the capabilities required for and problems associated with the off loading of a self-sustained containership (i. e., a ship with a permanent crane aboard) in the open sea. The Navy provided technical observers for this operation, which occurred off the coast of Fort Story, Virginia in December 1970. A report[1] on the operation has been issued.

As a follow-on to OSDOC I, the Army planned to conduct a further operational evaluation (OSDOC II) of the offshore discharge of a non-self-sustained containership (i. e., no permanent crane aboard) during October 1972 and accepted the Navy's proposal for a joint service exercise. The intent of the exercise is to use existing military or commercial equipments to discharge containers from ship-to-shore, and from an analysis of the results to provide direction to future research and development efforts.

Authorization[2] for the Navy to participate in OSDOC II was made by the Chief of Naval Operations. An Evaluation Planning Committee was established to coordinate and develop the OSDOC II test objectives.

The Naval Civil Engineering Laboratory (NCEL) was designated as the lead Navy laboratory for evaluating the NCEL concept of a floating crane/causeway ferry/beach components system including planning and pretesting prior to OSDOC II. NCEL proposed to off load 8'x8'x20' containers from a non-self-sustained containership using a floating crane, and to transport the containers ship-to-shore in a roll-off mode via a pontoon causeway ferry shuttle, and across hardened beached to a stabilized storage area. The concept, illustrated in Figure 1, proposed to use the best available present-inventory military or commercial equipment and techniques in terms of a floating crane, causeway ferry, truck/trailers and beach hardening material.

The operational scenario established for test is as follows. Referring to Figure 1, the containership (A) is moored offshore with the loading platform (B) secured to the containership, and the crane/platform (C) in turn secured to the containership outboard of the loading platform.* A causeway ferry (D) with empty truck/trailers is

---

[1]Army/Navy Test of OffShore Discharge of Containership, 5-9 December 1970 by M. E. Essoglou, NAVFAC.

[2]CNO ltr OP-404F/kss Serial 804P404 of 27 September 1971.

*In the actual tests the loading platform (b) and the crane/platform (C) were reversed in position.

end connected to one end of the loading platform, and empty causeway ferry (E) to the other. The crane deposits loaded containers on the loading platform; each container in turn is picked up by a front-end loader (Hyster) and loaded onto a trailer as it moves onto platform (B) and thence to the empty causeway ferry (E). The sequence is repeated until all truck/trailers are loaded and moved to causeway (E). The full causeway is then ferried to shore and beached, as illustrated by causeway (F), while causeway ferry (G) with empty truck/trailers is maneuvered into position vacated by causeway ferry (E). The cycle is then repeated in the reverse, or left hand order. The cycles continue in alternating right and left hand order until all containers are off loaded. At all times the truck/trailer traffic is in forward gear.

The primary mode of operation for the NCEL concept is to beach the causeway ferries directly on the shore and roll-off the truck/trailers with containers onto a hardened beach roadway. An alternate or secondary mode of operation is to end-connect the causeway ferries to a floating, moored causeway pier. This secondary mode would be used only if a sand bar hazard existed which would prevent direct beaching with a dry ramp for the vehicles.

For pre-test purposes the only readily available floating crane was a 100-ton capacity Navy YD barge crane located at the U. S. Naval Station, San Diego. This crane appeared to have an adequate lift/reach capability but an apparent disadvantage was its relatively small barge size/displacement which would tend to result in large barge motions in open sea swells.

It is desirable for the cargo handling system to operate in a sea state 3, i. e., significant wave height/period of 3.5 - 5.0 feet/2-7 seconds, 30-knot wind, and 7-foot surf. However, the available YD floating crane and LST (used to simulate the containership) were not expected to operate very efficiently in wave/swell heights over 2-3 feet or in wave periods over 7 seconds long.

Some primary problem areas encountered in OSDOC I were (1) the relative motions between the landing craft and crane/container, (2) alignment and placement of the container onto the trailer/chassis in the landing craft, (3) a sand bar at the landing site which restricted landing craft operation, and (4) removal of the trailer with container from the landing craft at the beach/surf zone.

These problem areas were to be alleviated or eliminated by the following features of the NCEL concept: (1) container placement onto a large pontoon barge by the crane to minimize the motions problem, (2) container placement on a trailer by a front lift loader to eliminate the alignment and relative motion problems, (3) a prepositioned moored pontoon causeway over a sand bar hazard with the pontoon ferry connecting to the offshore end, and (4) driving the truck/trailers forward off the causeways at the beach to eliminate container handling problems in the surf.

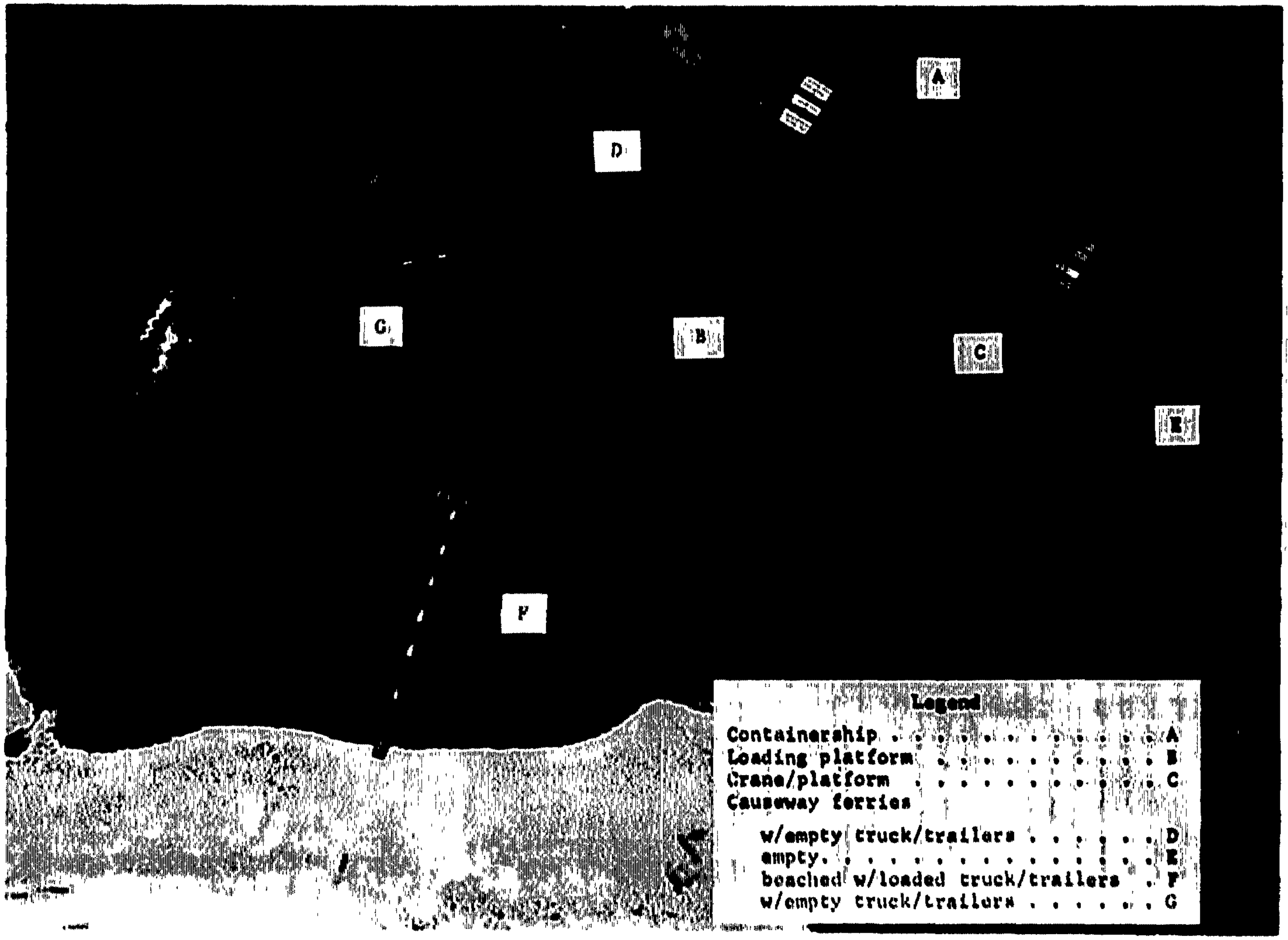


Figure 1. NCEL concept for ship-to-shore cargo transfer.

The pacing problems anticipated with the NCEL concept were planned to be tested prior to the OSDOC II exercise. These included the use of the large pontoon barge, unique mode of causeway end connection operation, available container handling and transport equipment, and direct beaching/retracting of the causeway ferries through the surf zone.

The purpose of this report is to provide an overview of the engineering test results and to develop recommendations concerning the use of the concept in the OSDOC II exercise.

ENGINEERING TESTS - CORONADO

These tests,* designed to evaluate the operational capabilities and limitations of the NCEL concept, were conducted in two phases: Phase One in the San Diego Harbor for familiarization; and Phase Two in the open sea for concept evaluation. The Commander Amphibious Forces Pacific Fleet was tasked to support the test operation at Coronado and provided the USS RACINE LST 1191 to perform the function of the containership. Naval Beach Group ONE and Amphibious Construction Battalion ONE provided the personnel and equipment to conduct the cargo shuttle operation. A 100-ton YD barge crane was provided and operated by the Public Works Center, U. S. Naval Station, San Diego. The U. S. Marine Corps, Camp Pendleton, provided the truck/trailers and drivers to transport the containers and installed and operated a pressure transducer in the surf area to measure the wave heights at the landing site. A surface riding wave gage (provided by Oceanographic and Geodetic Branch, PMR, Point Mugu, California) and current meter and tide gage (furnished and monitored by Louisiana State University Coastal Studies Institute, Baton Rouge, Louisiana) were installed at the ship site. Equipment to measure the barge crane motions was provided by the Naval Ship Research and Development Center, Carderock, Maryland. Two hardstands, about 100' by 100' each, were installed on Green Beach (Silver Strand, Coronado, California) for the Phase Two tests; one hardstand of AM-2 matting was placed by MCB-5, 31st NCR, during the period of 6-7 March, and the second hardstand of On-Fast material was placed by ACB-ONE and NCEL personnel on 7-8 March.

The engineering tests were to develop the following information:

1. Operational capability of the causeway ferry/6x15 barge/front lift loader concept, including the moored causeway operation to cross sand bar areas.
2. Operational capability of a floating crane (100-ton Navy YD type barge crane) to handle containers in calm water and open sea.
3. Capability of a floating crane to lift containers out of a container cell in the ship.

---

*The operational schedule for these tests is contained in Appendix H-1.

4. Wave data at ship and beach locations.
5. Current data at ship location.
6. Motion data on crane barge.
7. Acceleration data on spreader bar.
8. Feasibility of truck/trailers to transport containers in roll-off mode via the causeway and across the beach.
9. Capability of On-Fast and/or Mo-Mat to support the truck/trailers with containers across sand areas.
10. Capability of vacuum pads to secure the 6x15 pontoon barge to the crane barge.
11. Capability of rubber fenders to protect the crane barge and the 6x15 barge.
12. Capability of a power tagline on the crane to control container pendulation.

Sixteen (16) containers were stuffed with concrete weights by PWC, San Diego during the week of 1 March 1972; two (2) containers each to a gross weight of 44,8000 pounds and fourteen (14) containers each to a gross weight of 24,800 pounds. The containers were transferred from a barge to the LST using the 100-ton YD barge crane which was used later in the engineering tests. The operational times to transfer the containers are given in Table A.1. Fifteen (15) containers were placed on the LST (three 24,800-pound containers in the simulated cell, eleven 24,800-pound and one 44,800-pound container on the deck) and the sixteenth container weighing 44,800 pounds was positioned on the crane barge. Each container was numbered by location on the LST so as to be identifiable with any problems that might arise relative to handling. Figure 2 shows the container locations on the LST. The LST was moored to buoys 49-50, Figure 3, in the harbor for the first phase test, and in boat lane 5 at sea for the Second Phase tests, Figure 4. The LST used its 18,000-pound stockless anchor as a bow moor and a 6,000-pound preset STATO anchor as a stern moor.

The intent of the following tests did not include achieving production capability in transferring containers ship-to-shore, although operational timing is taken. High productivity would not be possible or expected with the type of crane and ship used, and the length and number of causeway ferries available. Rather it is intended to determine if the concept of a floating crane/causeway ferry/beach components is feasible for transferring containers from ship to shore. One anticipated advantage to the system being that standard type equipments are sed (in only a unique or variant mode from normal) so that the requirement for additional personnel should not be significantly increased.

Table A.1. Time to Load Barge to LST[1] (min)

Event \ Container	A1	A2	A3	A4	C1	C2	C3	F1	F2	F3[2]	F4	F5	H1	H2	H3	Avg
Swing and attach spreader to container	1.2	1.0	1.0	1.0	1.5	1.5	1.0	2.5	2.1	1.3	3.4	1.0	1.3	1.5	1.0	1.5
Swing and set container onto LST deck	3.5	2.0	2.4	2.7	2.8	2.1	2.7	5.0	2.5	5.7[4]	3.4	1.9	4.3[3,4]	3.0[3]	1.7[3]	3.0

[1]Container moved from barge to LST

[2]44,800-pound container

[3]Set into container cell

[4]Main block used

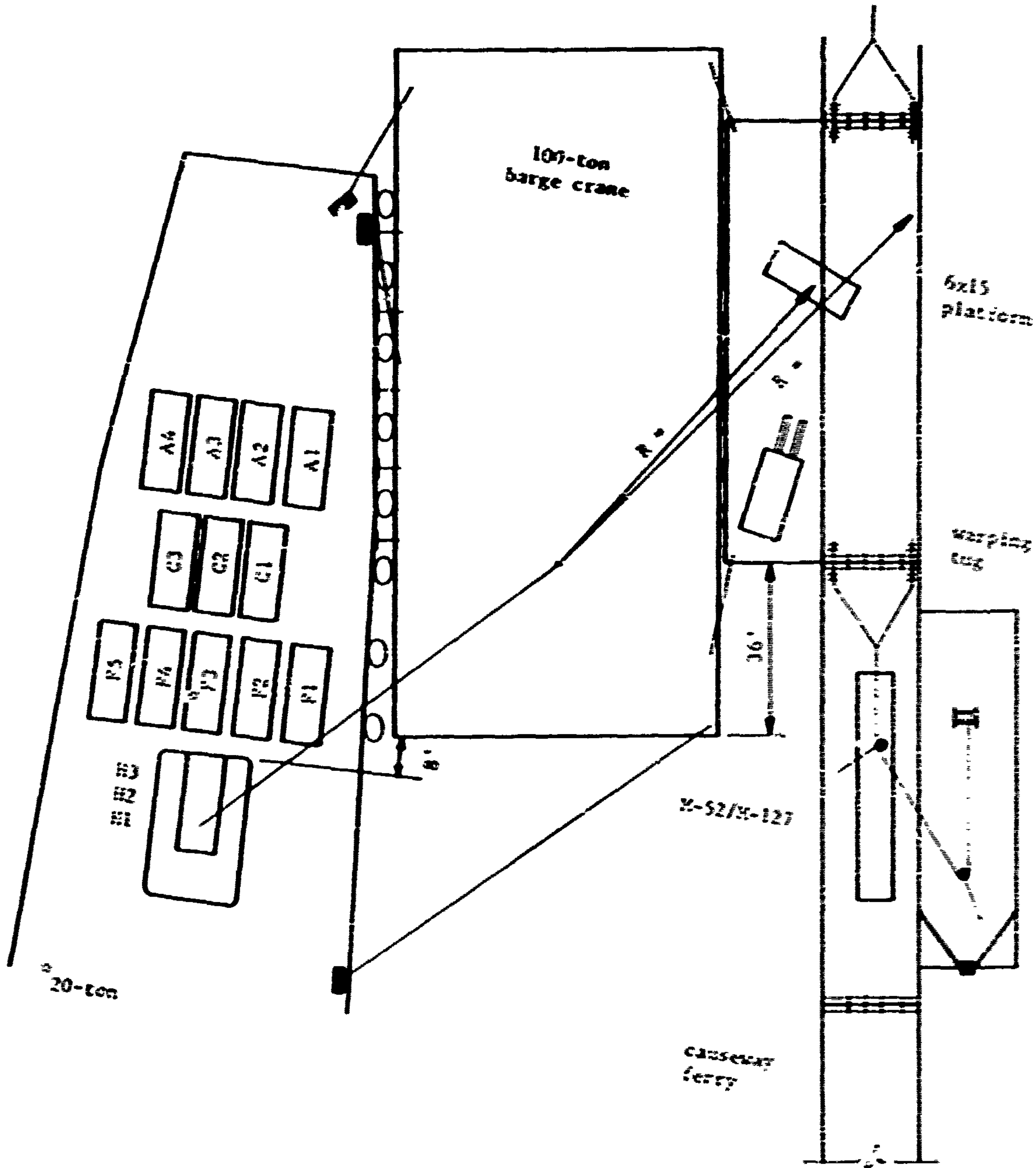


Figure 2. LST/crane barge location.

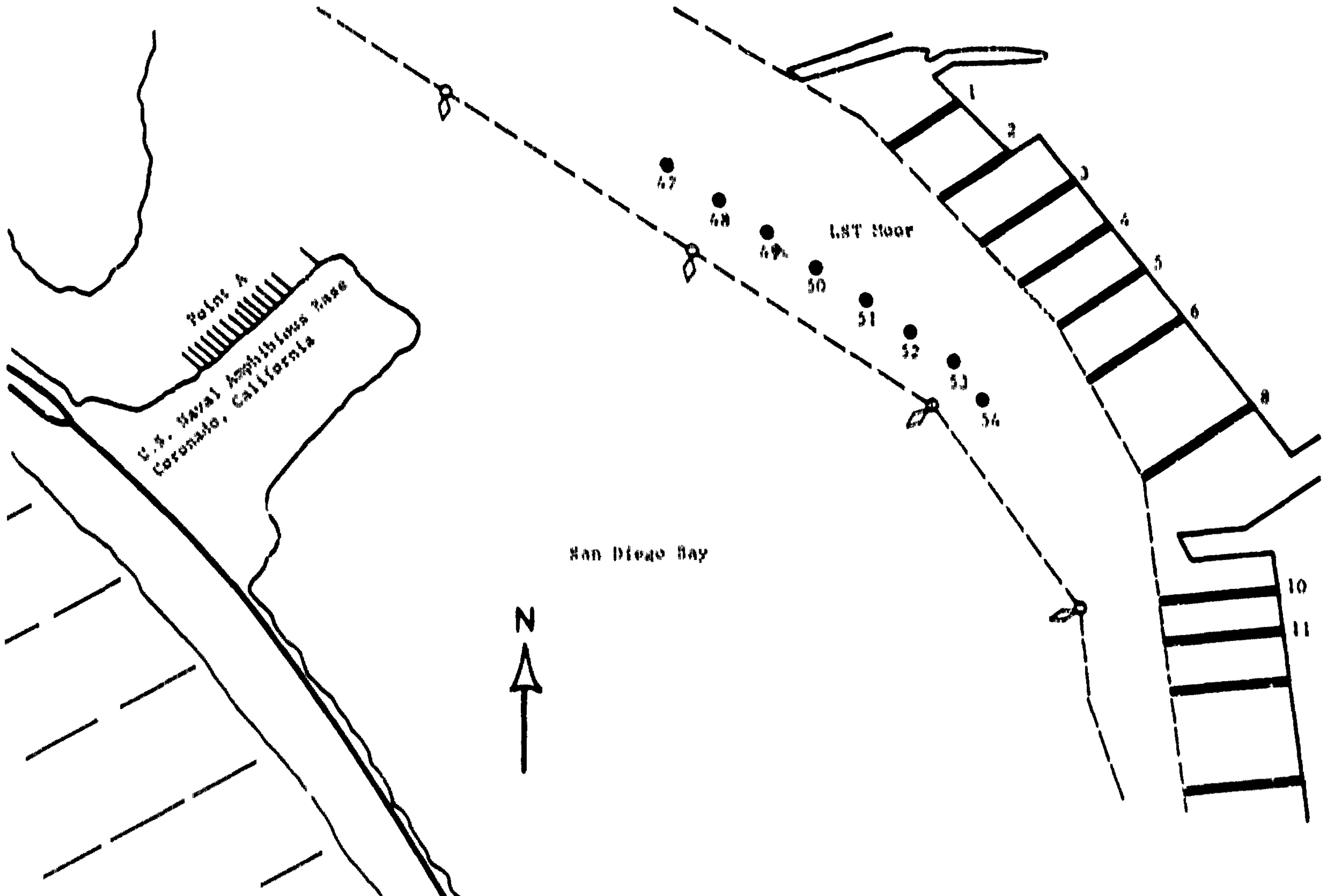


Figure 3. Phase 1 test site.

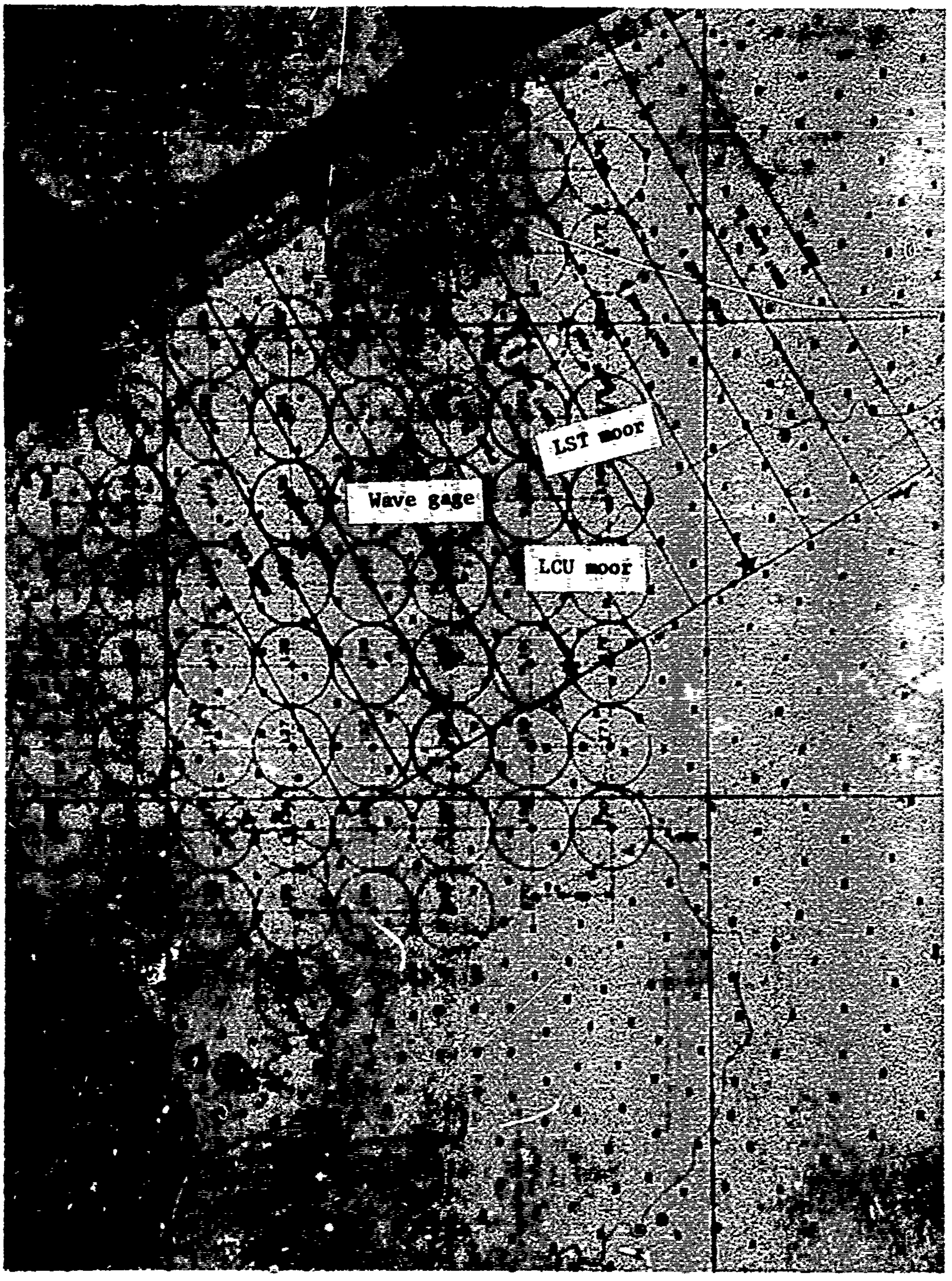


Figure 4. Phase II test site.

A. SHIP-TO-SHORE SUBSYSTEM

1. Causeway Shuttle - First Phase

The first phase tests were conducted in San Diego Harbor on 15-16 March as outlined in the operational schedule, Appendix H.1. Eight containers (A1, A2, A3, A4, H1, H2, H3, C3), weighing 24,800 pounds each, were moved ashore on 15 March using two 4-section ferries. The three containers (H1, H2, H3) which had been positioned in the cell on the LST were lifted to the LST deck during the shuttle period of containers A1 through A4. The operational times to transfer the eight containers from ship to shore are given in Tables A.2 and A.3. On 16 March, seven additional containers (6 each 24,800 pounds and 1 each 44,800 pounds) were moved ashore, using two 3-section ferries and a pre-positioned (moored) pontoon beach ramp section at the unloading site to provide the end connection point. Nine (9) minutes were required to transfer the one 44,800 pound container from the crane barge deck to the 6x15 barge and finally to load it onto the trailer using the front lift loader. This above average transfer time was caused by several factors: (a) the 23-ton lift capacity of the front lift loader was marginal thus slowing this operation, (b) the rear wheels of the loader tended to lift off the deck which was partially caused by the forks not being fully inserted into the pockets in the containers, (c) the fork tines were too thick to fit into some container pockets, and (d) it was necessary to use the main hook to handle this container. The main hook speed is only about 1/3 that of the auxiliary hook used to handle the lighter containers. Figures A.1 through A.10 show the harbor operation during the transfer of the containers from the ship to the concrete unloading dock. Operational times are listed in Tables A.2 and A.3.

The fourteen (14) 24,800-pound containers were backloaded onto the LST on 16 March using the 4-section causeway ferries; the 44,800-pound container was retained ashore for other tests. Two shuttles were made carrying seven (7) loaded truck/trailers on each trip. The average time to move a container directly from the trailer to the LST deck was 3.8 minutes. Figures A.11 and A.12 show this backloading operation.

2. Causeway Shuttle - Second Phase

An eight (8) section causeway, Figure A.13, was moored at the open beach landing site on 20 March. Unloading operations began on 21 March with four (4) truck/trailers being loaded onto the 4-section causeway ferry, Figure A.14, and moving to the LST/crane barge area about 2,500 yards offshore. Lines securing the crane barge to the LST and the lines tying the 6x15 barge to the crane barge parted as a result of relative surge motions. The crane barge surge in one direction was observed to be 6-8 feet in 4-6 seconds while no apparent surge motions were observed in the LST or causeway ferries/6x15 barge. Swell heights at ship were 3.0 to 5.0 feet with 12 second period. It was decided to postpone unloading until more adequate lines and fenders were installed.

Table A.2. Operational Time (min) to Off Load Container
Ship to Trailer

Event / Container No.		A1	A2	A3	A4	C1	C2	C3	F1	F2	F3[2]	F4	F5	H1	H2	H3	Avg	
Swing and attach spreader to container	H[3]	2.0	2.0	1.0	3.7	3.0	3.0	1.0	3.0	1.0	---	1.0	1.0	2.0	2.0	2.0	2.0	
	O.S.	2.0	1.0	3.0	2.0	3.0	2.0	2.0	2.0	---	---	---	---	1.0	2.0	2.0		2.0
Swing and set onto 6x15 barge	H	2.0	2.0	2.0	4.3	2.0	2.0	2.0	2.0	1.0	---	1.0	1.0	2.0	2.0	2.0	2.0	
	O.S.	3.0	7.0	2.0	2.0	5.0	3.0	3.0	4.0	---	---	---	---	4.0	2.0	2.0		3.0
Front lift load onto trailer	H	3.2	3.2	3.5	4.8	4.0	4.0	2.0	4.0	4.0	---	4.0	3.0	5.0	4.0	4.7	3.8	
	O.S.	4.0	2.0	4.0	9.0	2.0	2.0	4.0	2.0	---	---	---	---	2.0	4.0	3.0		3.4

[1] For container location on LST, see Figure 2.

[2] 44,800-pound container.

[3] H - Harbor
O.S. - Open sea

Table A.3. Operational Time (min) Ship to Shore

Event / Ferry	Harbor-1		Harbor-2		Open Sea	
	Ferry #1	Ferry #2	Ferry #1[1]	Ferry #2	Ferry #1	Ferry #2
Load empty trucks onto ferry	3.0	3.0	8.0	3.0	4.0	4.0
Retract from beach or ramp	5.0	3.0	2.0	2.0	3.0	11.0
Shuttle to 6x15 barge - 2,500 yds.	28.0	35.0	28.0	34.0	29.0	36.0
End connect to 6x15 barge	3.0	3.0	5.0	3.0	2.0	5.0
Move containers from ship to trailers	33.7	30.7	27.0	26.0	41.0	32.0
Disconnect from 6x15 barge	1.0	4.0	1.0	2.0	4.0	3.0
Shuttle containers to beach - 2,500 yds.	32.0	24.0	30.0	24.0	41.0	25.0
Unload trucks from ferry	3.1	2.0	5.0	4.0	4.0	4.0
Total time	108.8	104.7	106.0	98.0	128.0	120.0

[1]Transferred 3 containers (including one 44,388-pound); other ferries transferred 4 containers.

NOTE: Harbor - 1 test was with 4-section causeways docking on ramp; Harbor - 2 tests were with 3-section causeways end connecting to a causeway pier.

Figure A.1. End connecting ferry to 6x15 barge.

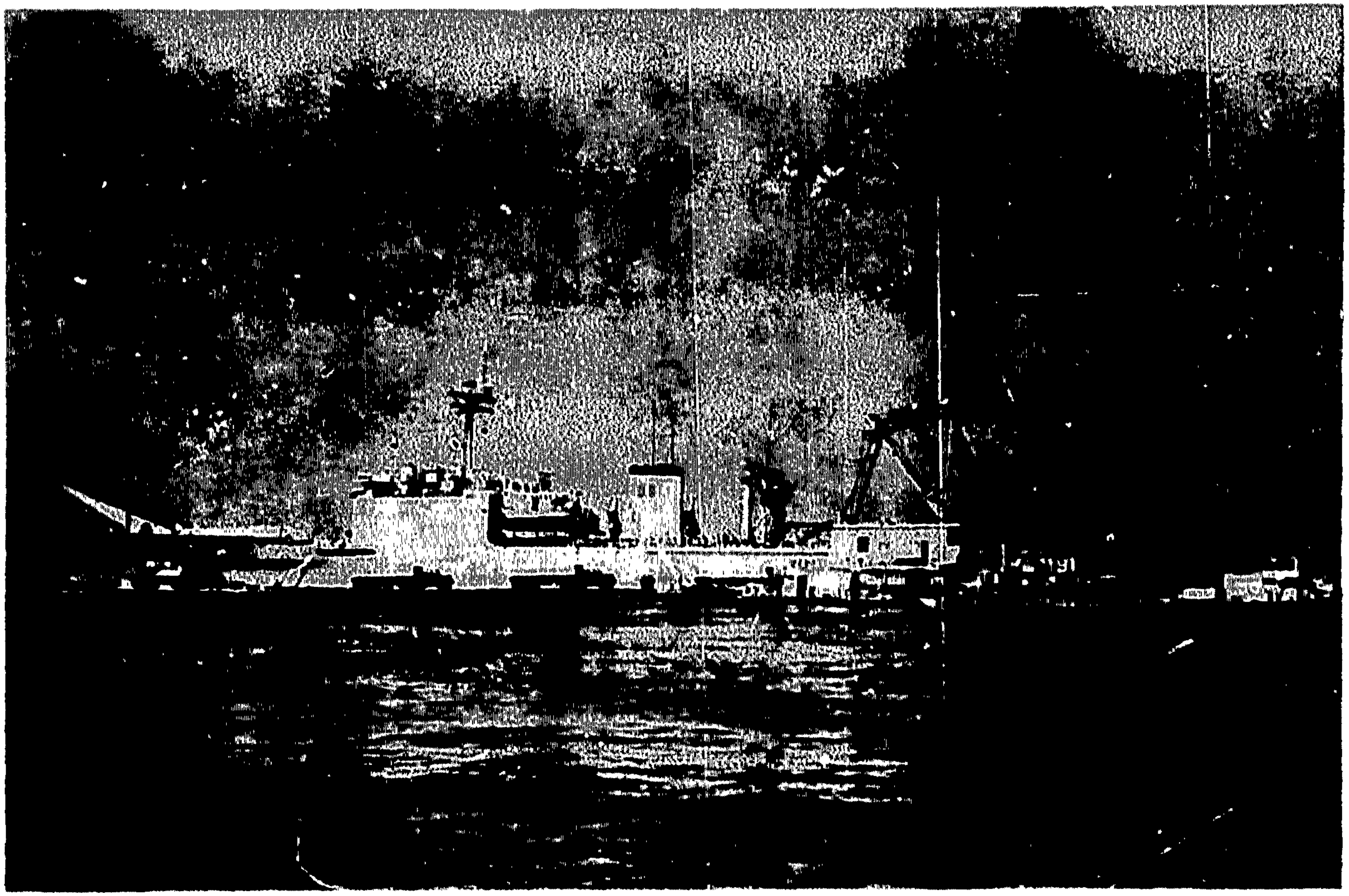


Figure A.2. Empty truck/trailers on causeway ferry awaiting loading operation.

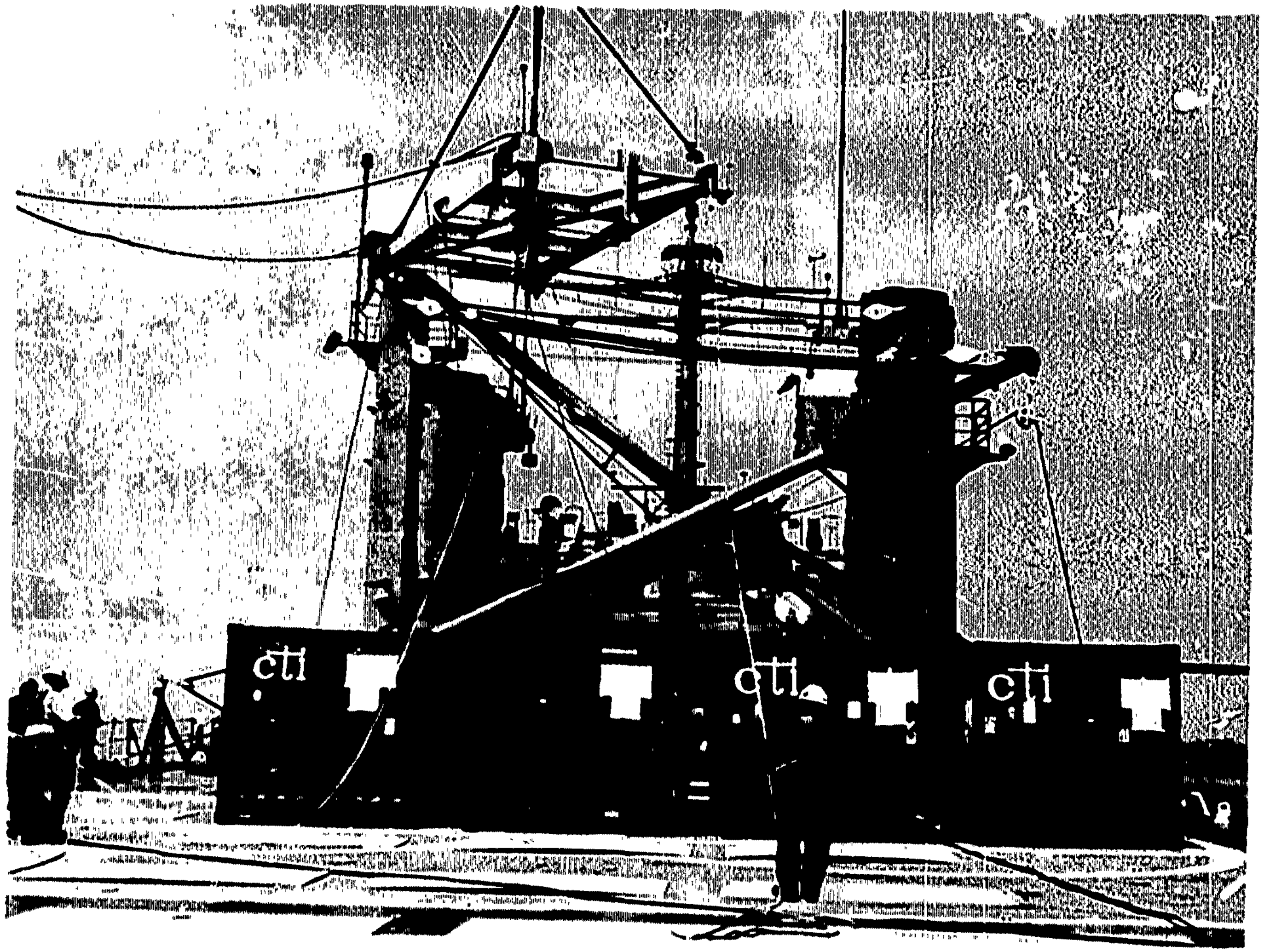


Figure A.3. Containers loaded to 24,800 pounds on LST deck. Note plywood positioned on deck for containers; spreader bar overhead.

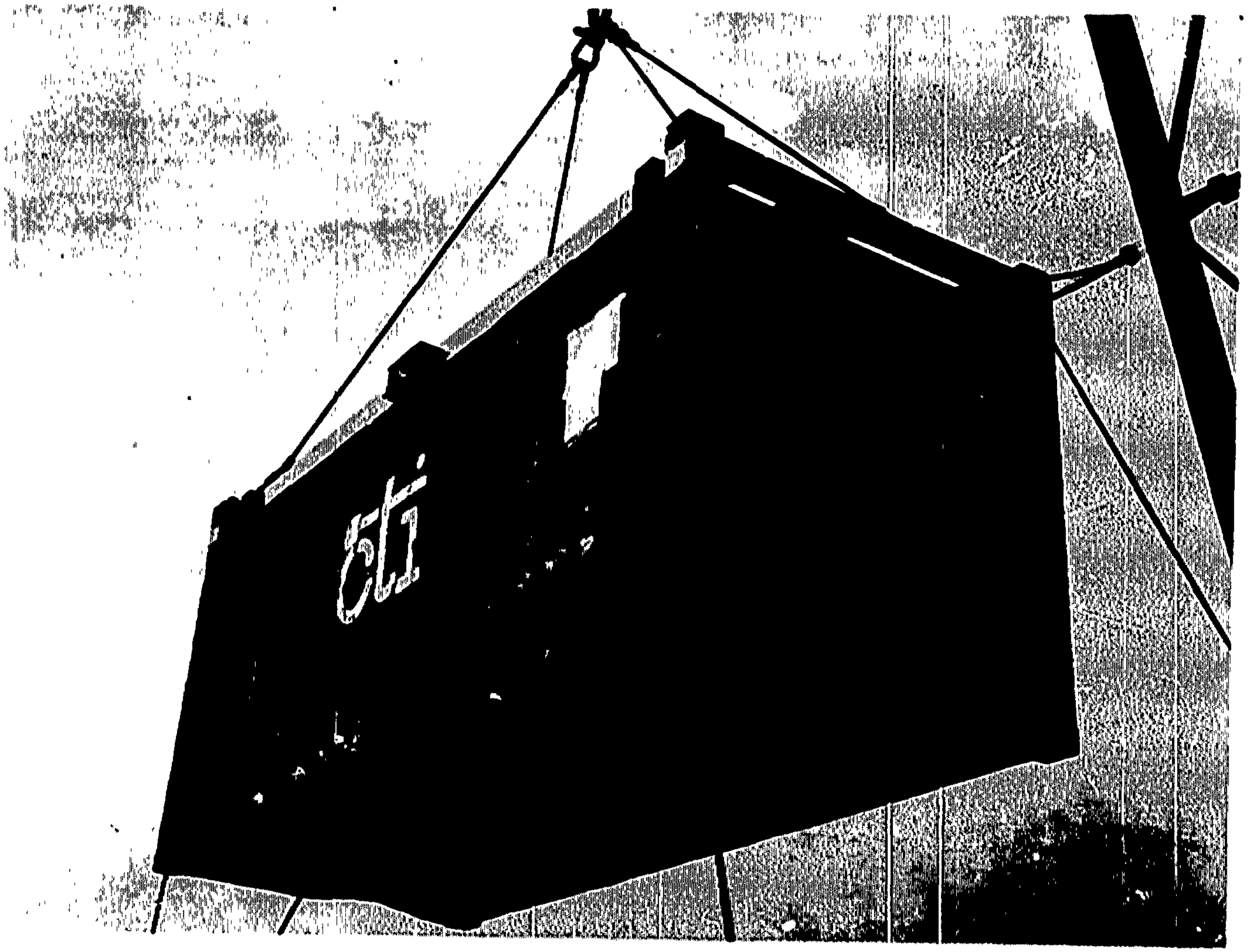


Figure A.4. 24,800 pound container being transferred with spreader bar.

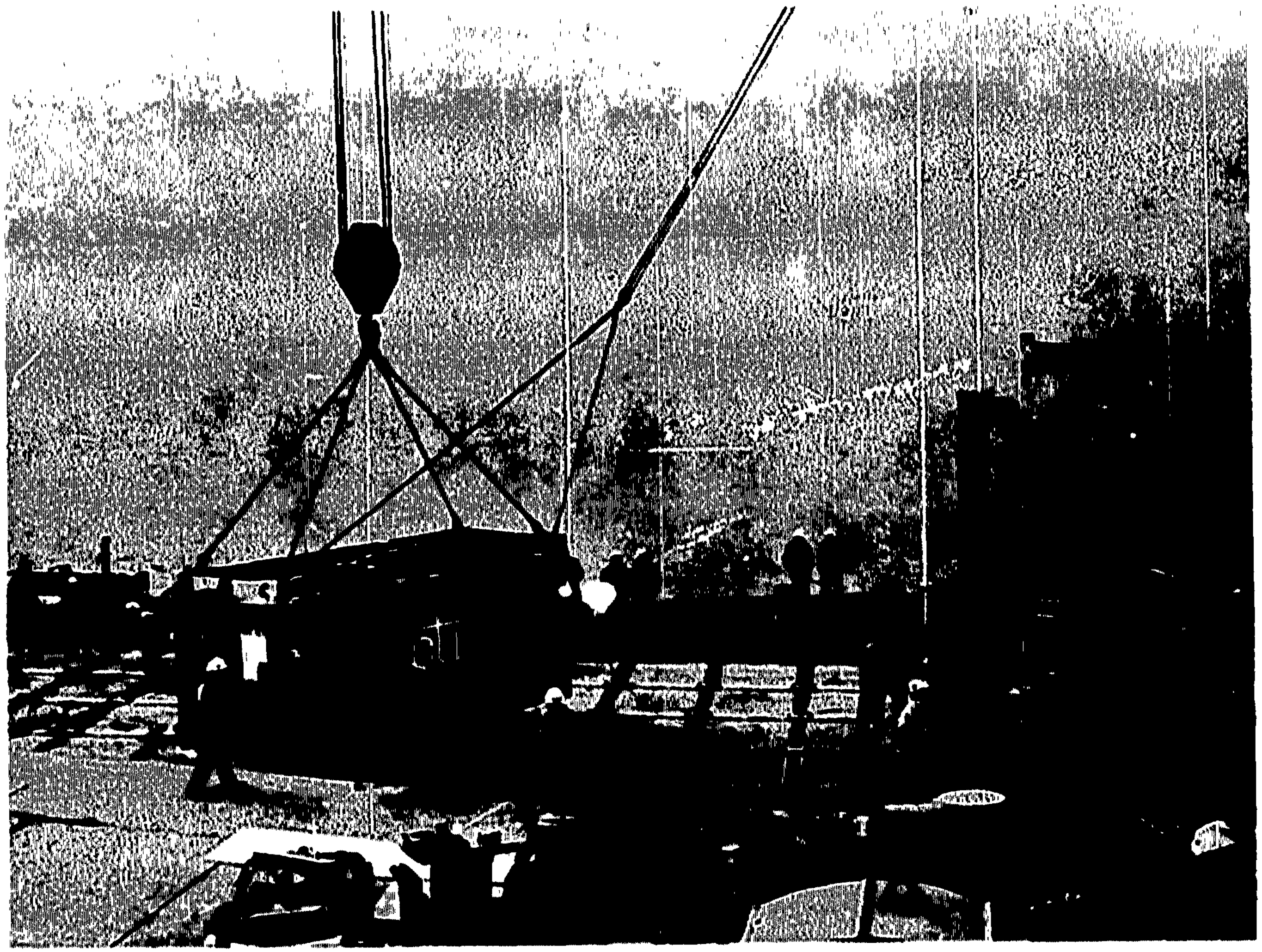


Figure A.5. 24,800 pound container being lowered onto 6x15 barge; manual and powered taglines employed for control.

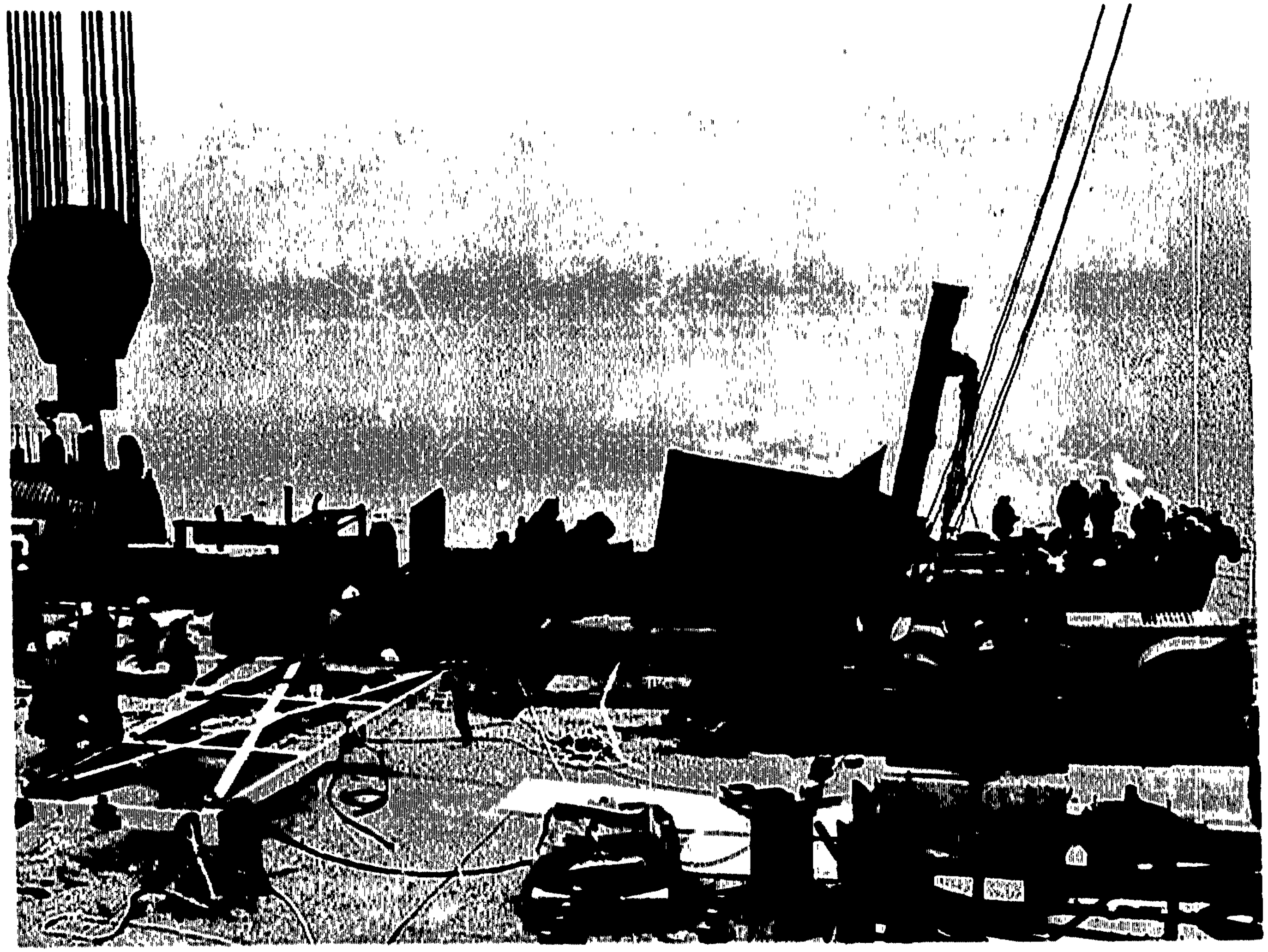


Figure A.6. Container being lifted by front lift loader.

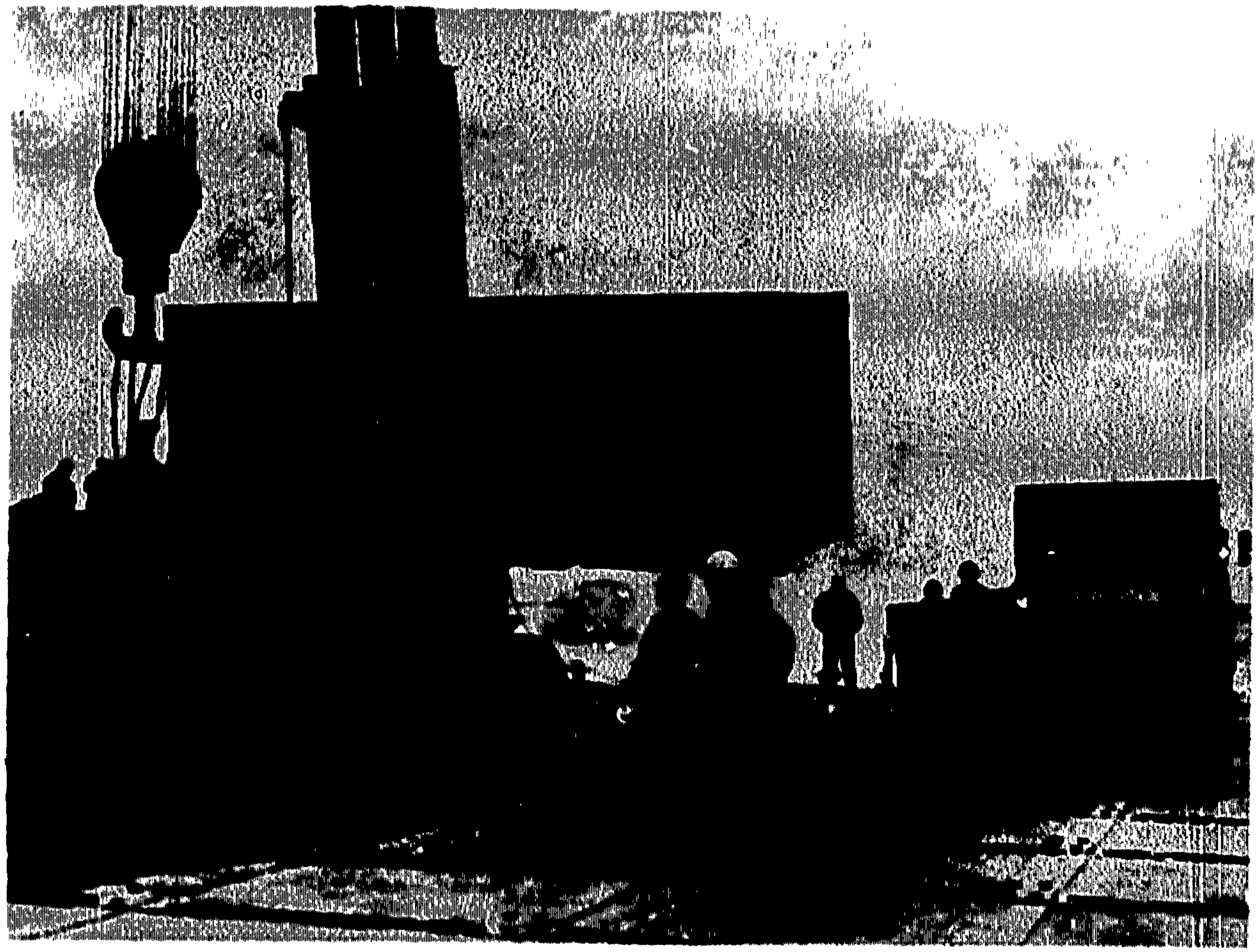


Figure A.7. Container being moved to M127 trailer parked on 6x15 barge.

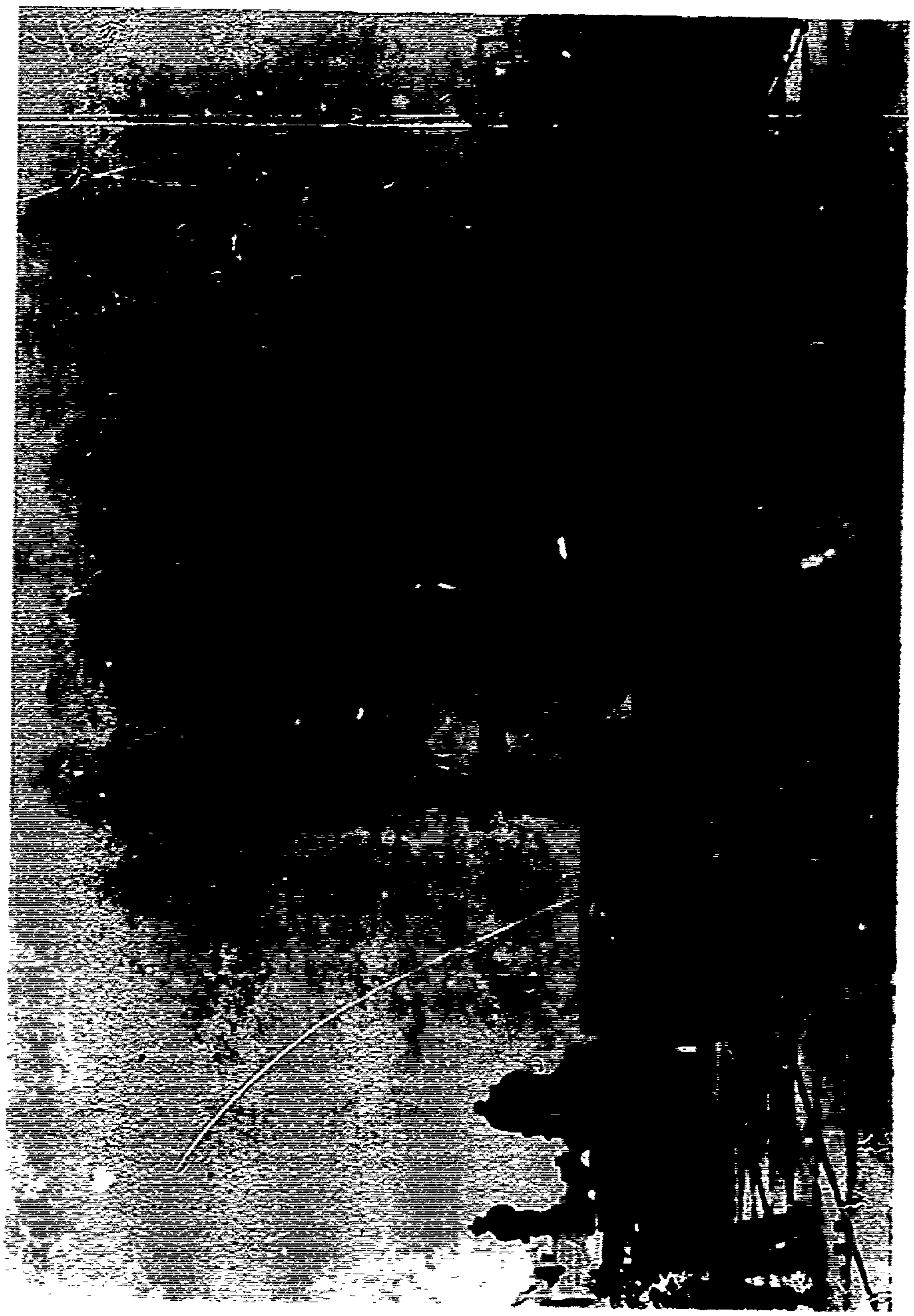


Figure A.8. Container being loaded onto M127 trailer.

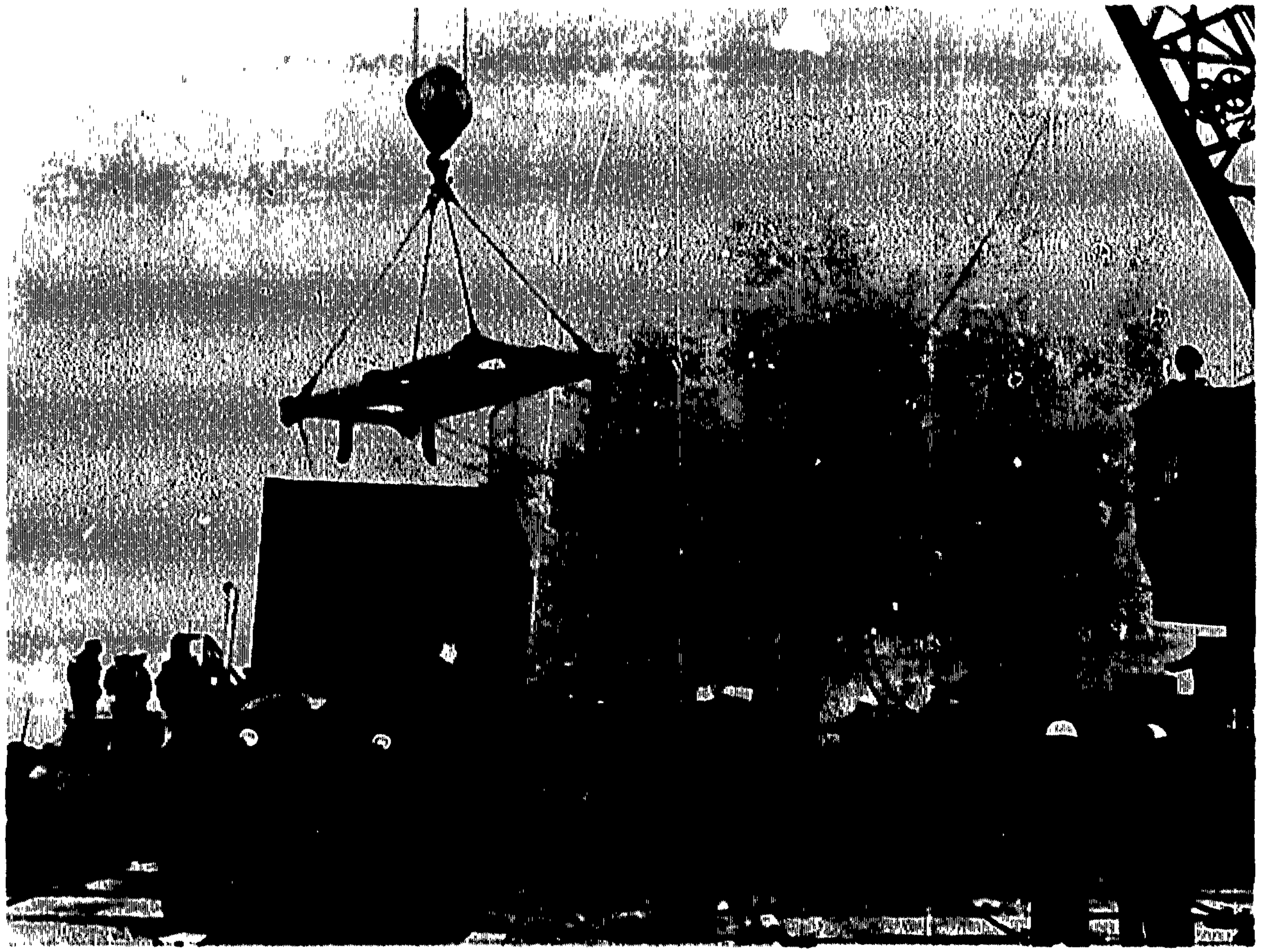


Figure A.9. Container loading operation on trailer completed.

Figure A.10. Truck/trailer with container rolls off causeway onto concrete ramp.

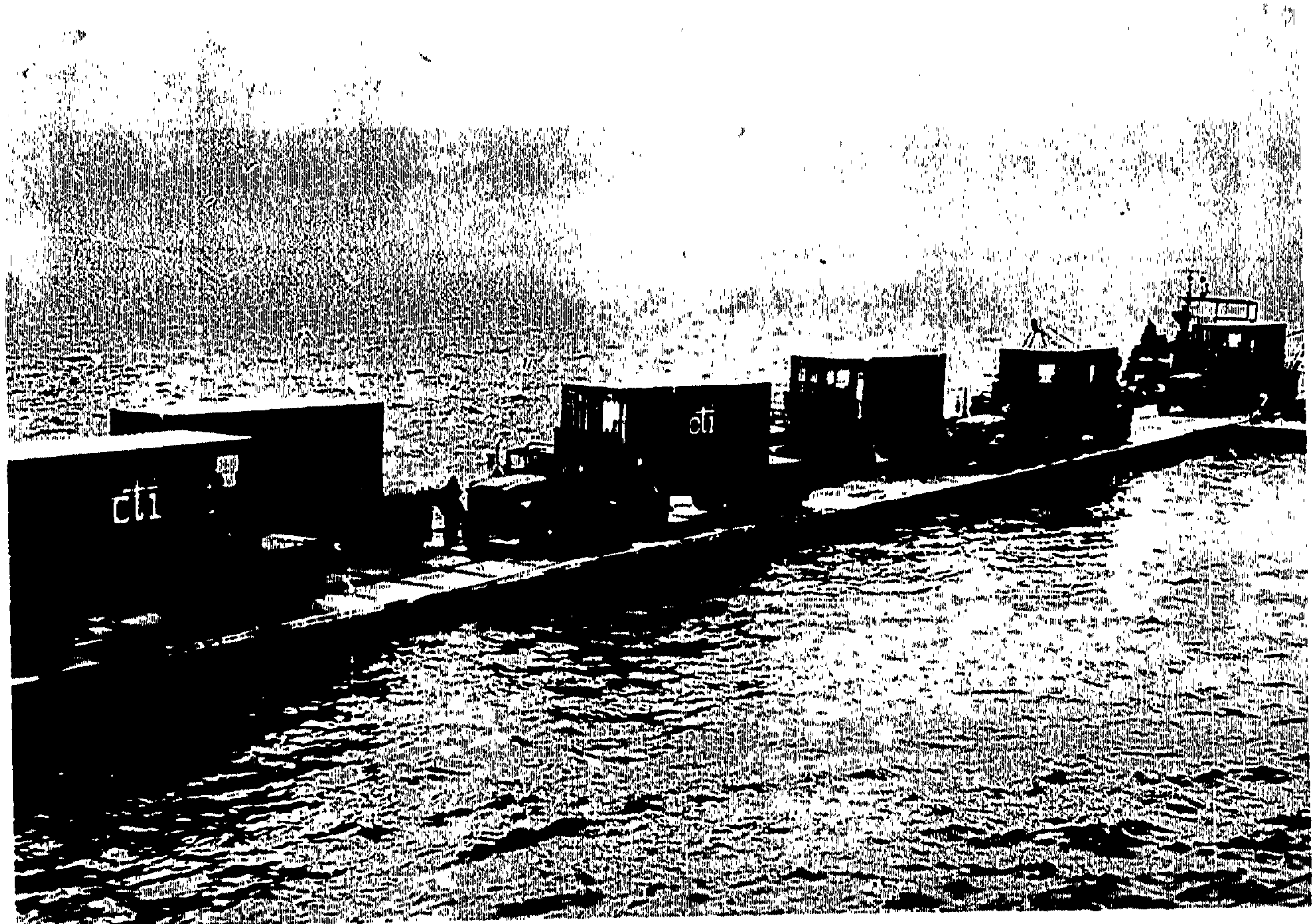


Figure A.11. Containers being backloaded onto LST. Note that up to three truck/trailer with containers were accommodated on one causeway/section.

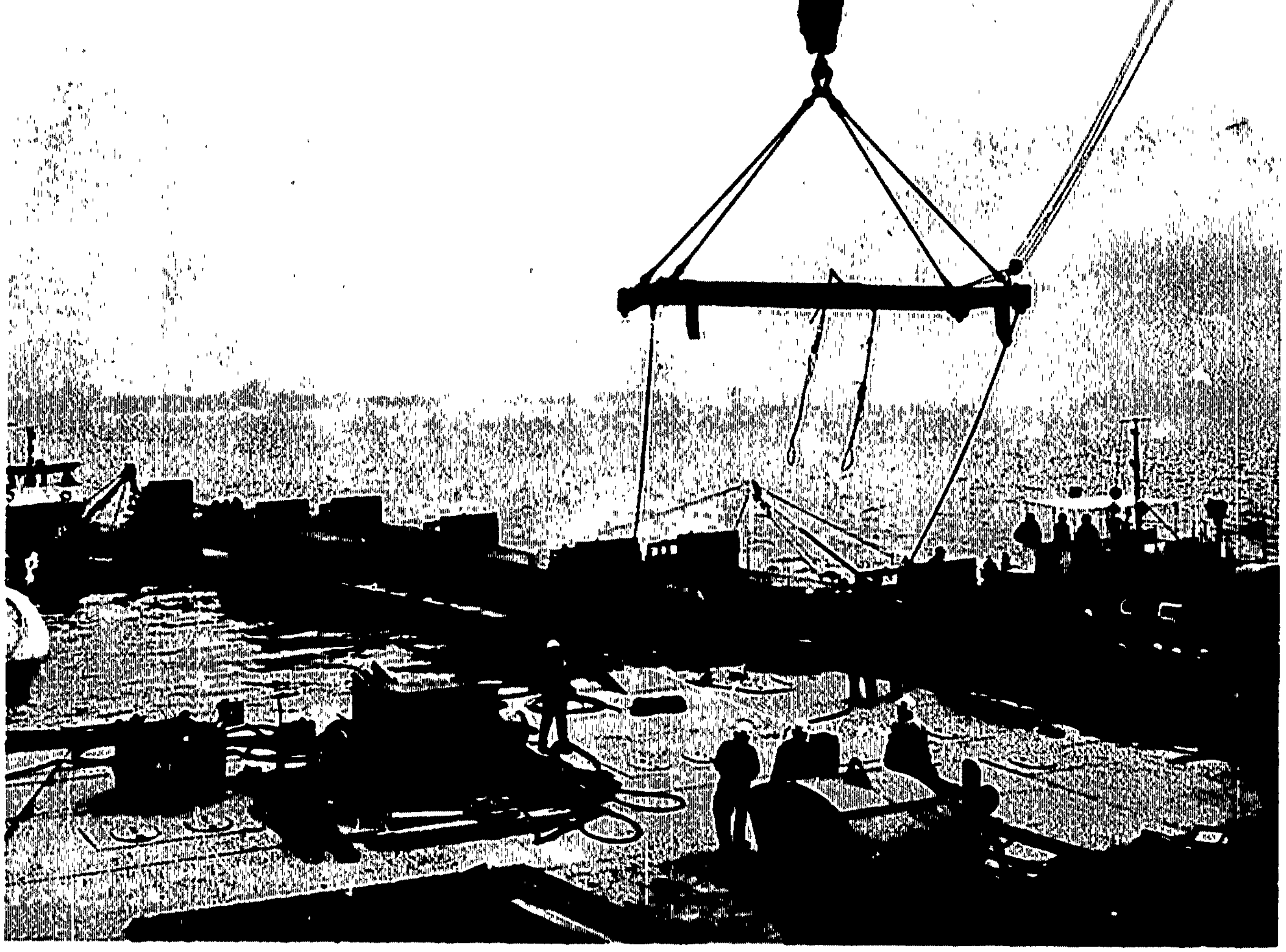


Figure A.12. Seven units of empty trailers were loaded onto a four-section ferry.

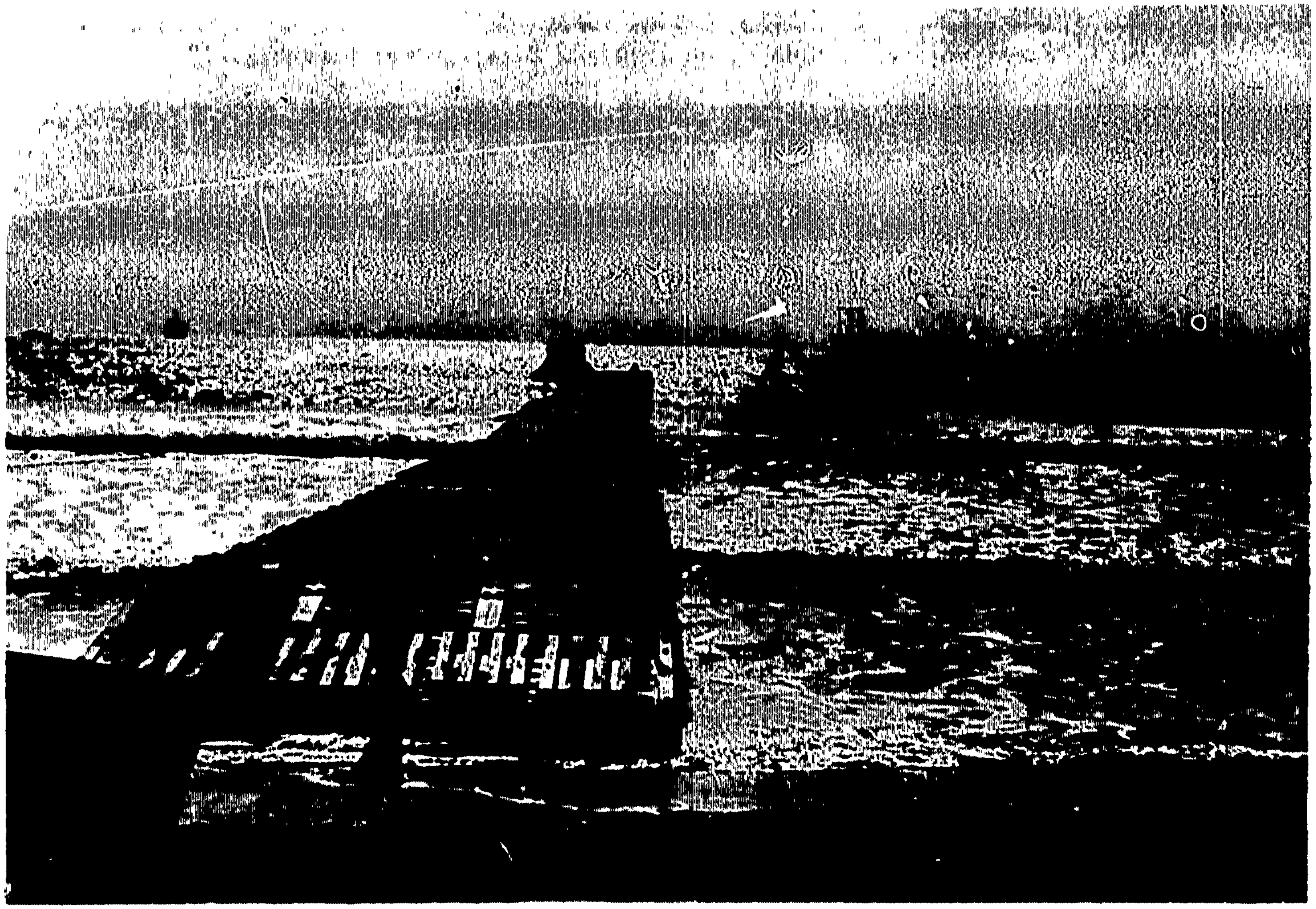


Figure A.13. Warping tug used to install anchors for beached eight section causeway.

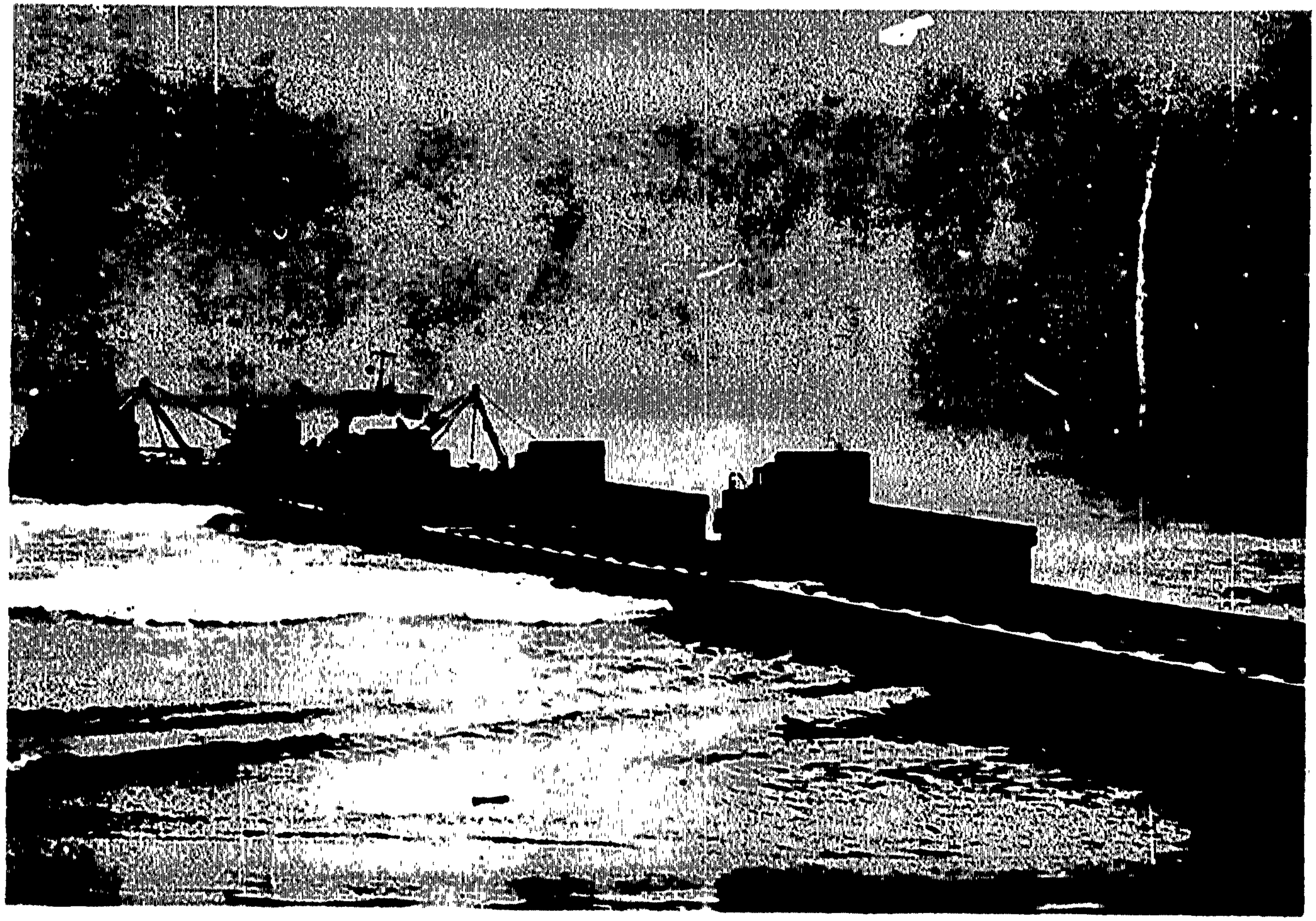


Figure A.14. Driving M52/M127 units onto 4-section ferry.

On 22 March the crane barge was tied to the LST and the 6x15 barge, using the more adequate mooring configuration. Two shuttle cycles, of 4 truck/trailers each, were made in the morning. Eight (8) containers, weighing 24,800 pounds each, were unloaded by beaching the 4-section ferries and driving the truck/trailers ashore. Figure A.15 through A.19 show this operation.

During the morning of 23 March, a 3-section ferry was end connected to the 8-section, moored causeway. Waves were 3-5 feet in height. Three empty truck/trailers were driven from the beach, across the 8-section causeway and onto the 3-section ferry. The ferry was moved to the 6x15 barge where the trailers were loaded with 24,800-pound containers. When the 3-section ferry returned to the 8-section, moored causeway, the waves had increased in height to 8-9 feet. (See Section E.1) Initial attempts to end connect the ferry to the causeway were unsuccessful. This end connection operation was terminated because of the danger to personnel. Consequently, no containers were moved ashore across the 8-section, moored causeway. See Figures A.20 and A.21. Average operational times for 22-23 March are listed in Tables A.2 and A.3.

During the time when the end connection operations were terminated, the overall exercise was terminated at the ship because of damage occurring to the LST and crane barge as a result of the severe sea conditions.

3. Front Lift Loader

This container handling equipment was used to lift the containers from the 6x15 barge deck and to position the container on the trailer which was moved from the causeway ferry to the 6x15 barge. See Figures A.22 and A.23. The front lift loader was a Hyster, Model 460B, with a rated lift capacity of 46,000 pounds at 48-inch distance from the face of the forks to center of gravity of the load. The front lift loader weighed 72,000 pounds, was 343 inches long (including 8-foot forks) and was 119 inches wide. This equipment handled the 24,800-pound containers on the forks without difficulty. The equipment lifted the 44,800-pound container and set it on the trailer in the harbor operations, but it was the observer's opinion that this operation would be dangerous in rough water because the rear wheels were carrying practically no load and the loaded container could tilt forward in rough wave action. The tines on the loader, originally 12 feet long, had been shortened to 8 feet for purposes of operational clearances on the 6x15 barge. However, the tines were very thick at their root because of the original 12-foot length and this extra thickness prevented insertion of the tines into some container pockets. Also the tines would bind or hang on the pockets and trailer bed thereby slowing the operation.

4. 6x15 Pontoon Barge

The 6x15 barge was used to end connect the causeway ferries, provide a platform to maneuver the front lift loader to pick up containers and

set them on the trailers, and as a relatively large area for the crane to place the containers. The barge was composed of two, standard, 3x 15 causeway sections with one section modified by replacement of its P5M pontoons by P5F pontoons. This modification permitted the standard causeway ferries to be end connected to both ends of the 6x15 barge. The deck of the barge was reinforced with 5/16-inch thick, steel plate in the area where the containers were set down by the crane. The loader picked up the containers and maneuvered the load to the trailer while operating on the reinforced area. At times, it was observed that in placing the container onto the barge deck, a space about 27 feet long was needed to accommodate the pendulation of the container in its 20-foot direction. The barge operated satisfactorily during all the tests.

The rubber fenders provided for the 6x15 barge were heavy duty modular units with steel plates molded into the rubber for welding to the side of the pontoons. The units were B. J. Marine products, Model No. 54-4300, "D" type, 8-inch deep having a resisting force of 70,000 pounds per foot for 4½-inch deflection. These fenders provided adequate protection between the pontoon platform and the crane barge.

B. UNLOADING/HANDLING SUBSYSTEMS

1. Navy Floating Crane

NCEL conducted an investigation of several types of cranes to establish performance feasibility and cost of available equipments for the OSDOC II exercise. A preliminary analysis of the crane alternatives was made resulting in a recommendation for the OSDOC II exercise. The two leading crane alternatives in order of preference were: (1) A P&H Model 6250-TC mobile truck crane mounted on a 10x30 NL pontoon barge and, (2) a 100-ton Navy floating crane (YD-225). The investigation showed that while the mobile truck crane possessed superior operational characteristics, both cranes were capable of off loading a containership in the OSDOC II exercise. Based on availability, the Navy 100-ton floating crane was selected for use in the Coronado engineering tests.

The YD-193 Navy floating crane, Figure B.1, is a non-self-propelled barge crane with full 360° rotation generically classed as a 100-ton floating crane. The barge measures 140 feet by 70 feet and displaces 3,400,000 pounds with a mean draft of 6.1 feet. The YD-193 is used normally as a dockside crane. The lift characteristics are summarized in Table B.1.

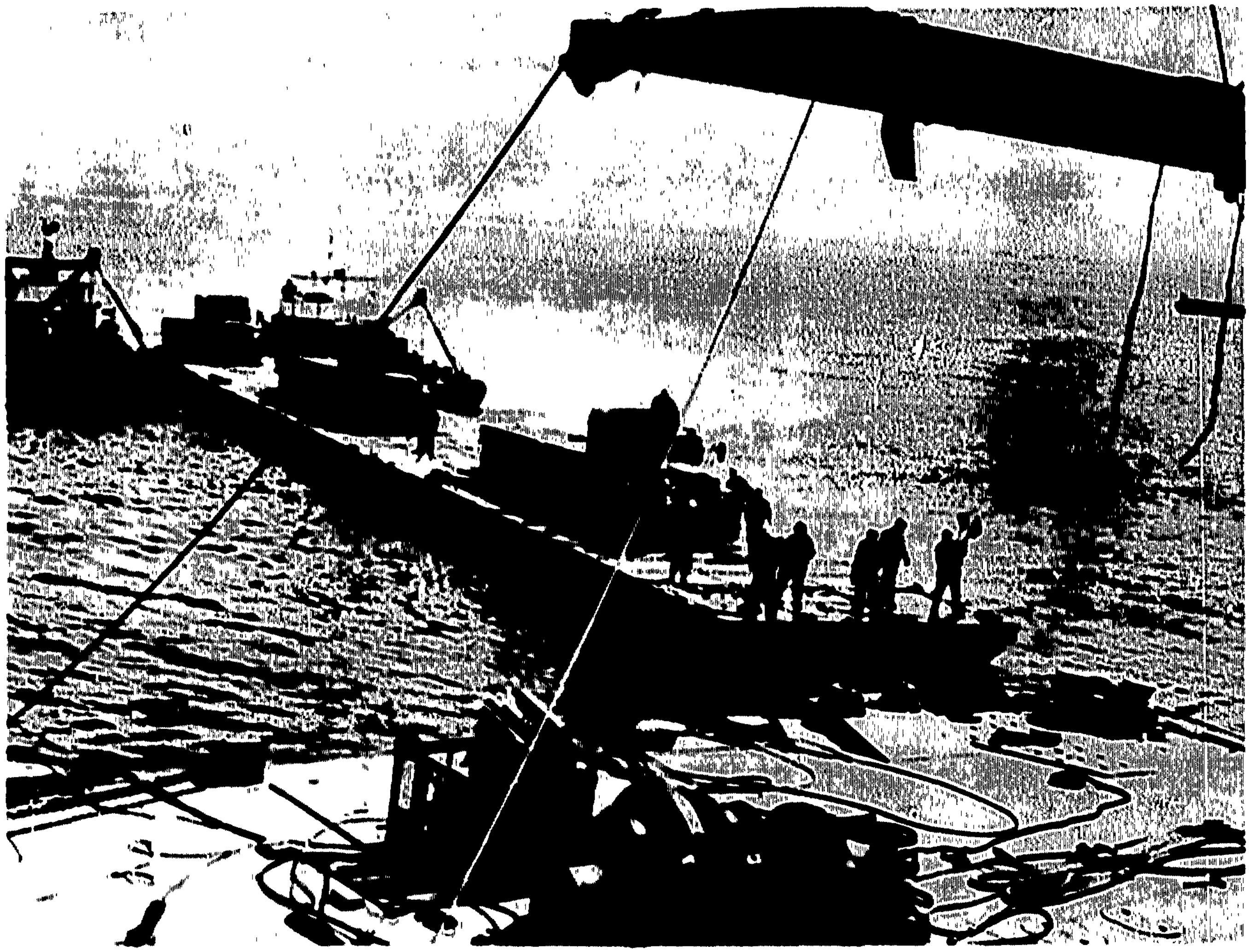


Figure A.15. Ferry approaching 6x15 barge in open sea.

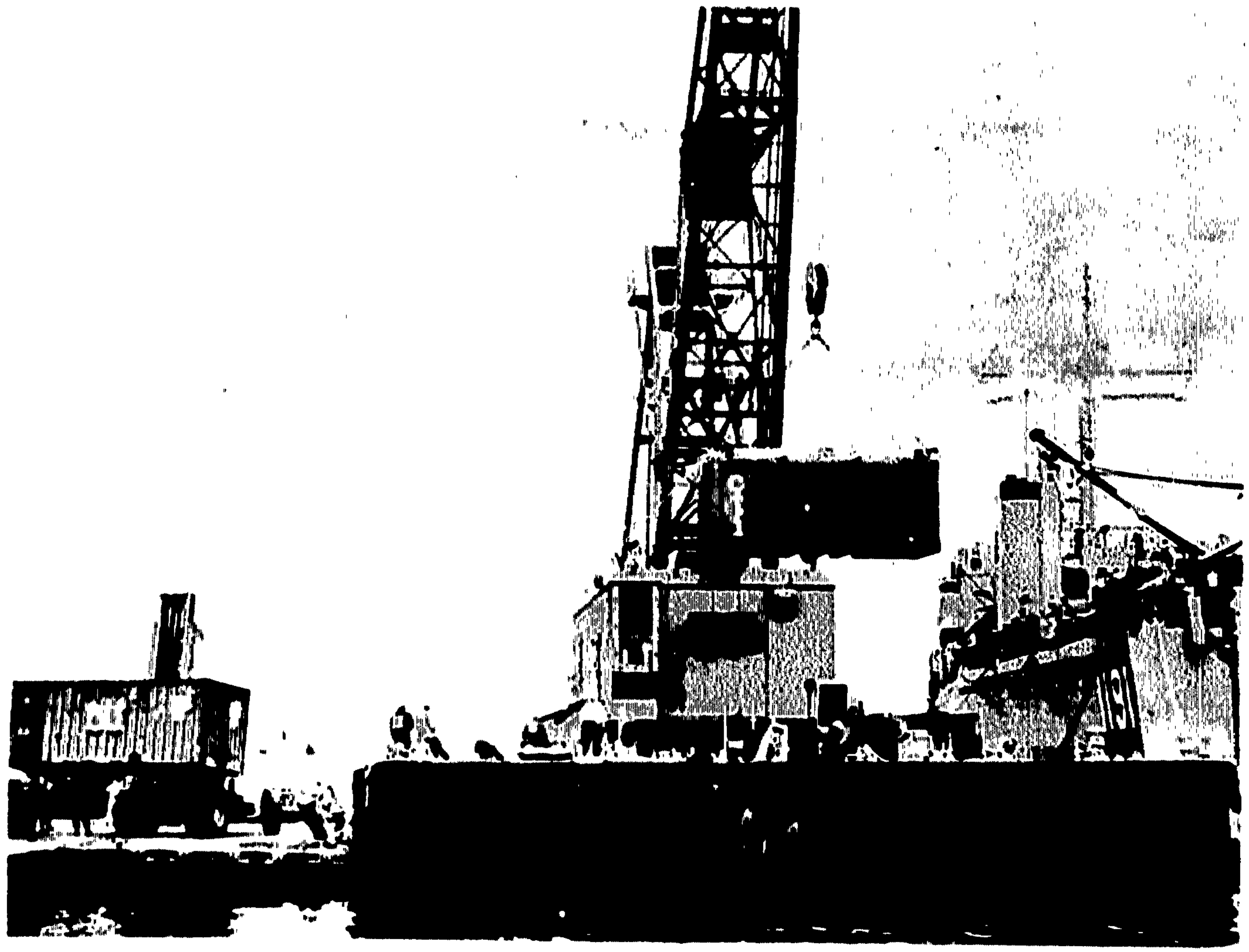


Figure A.16. Transferring containers from ship to 6x15 barge to trailer.

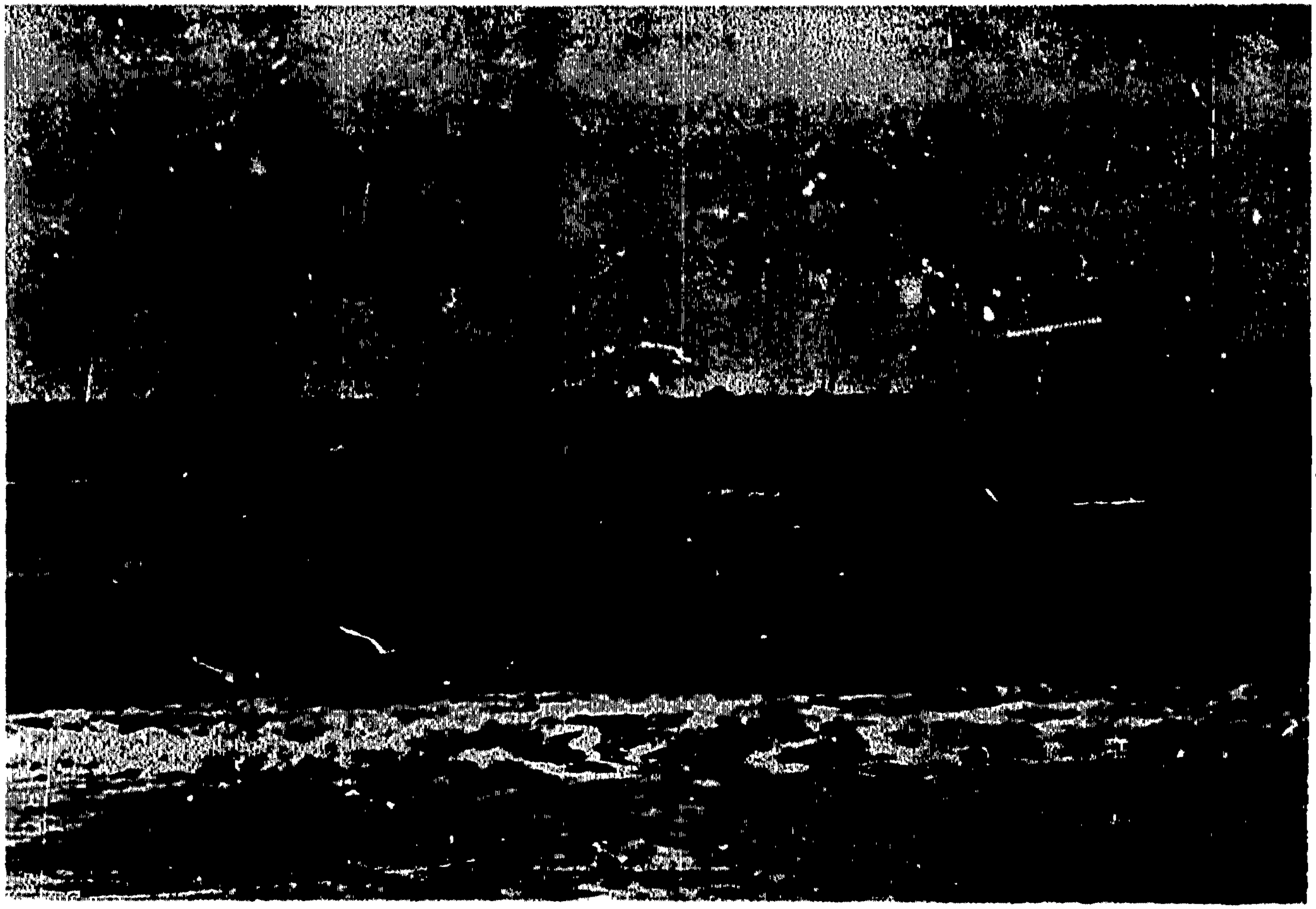


Figure A.17 Four-section causeway approaching beaching site.

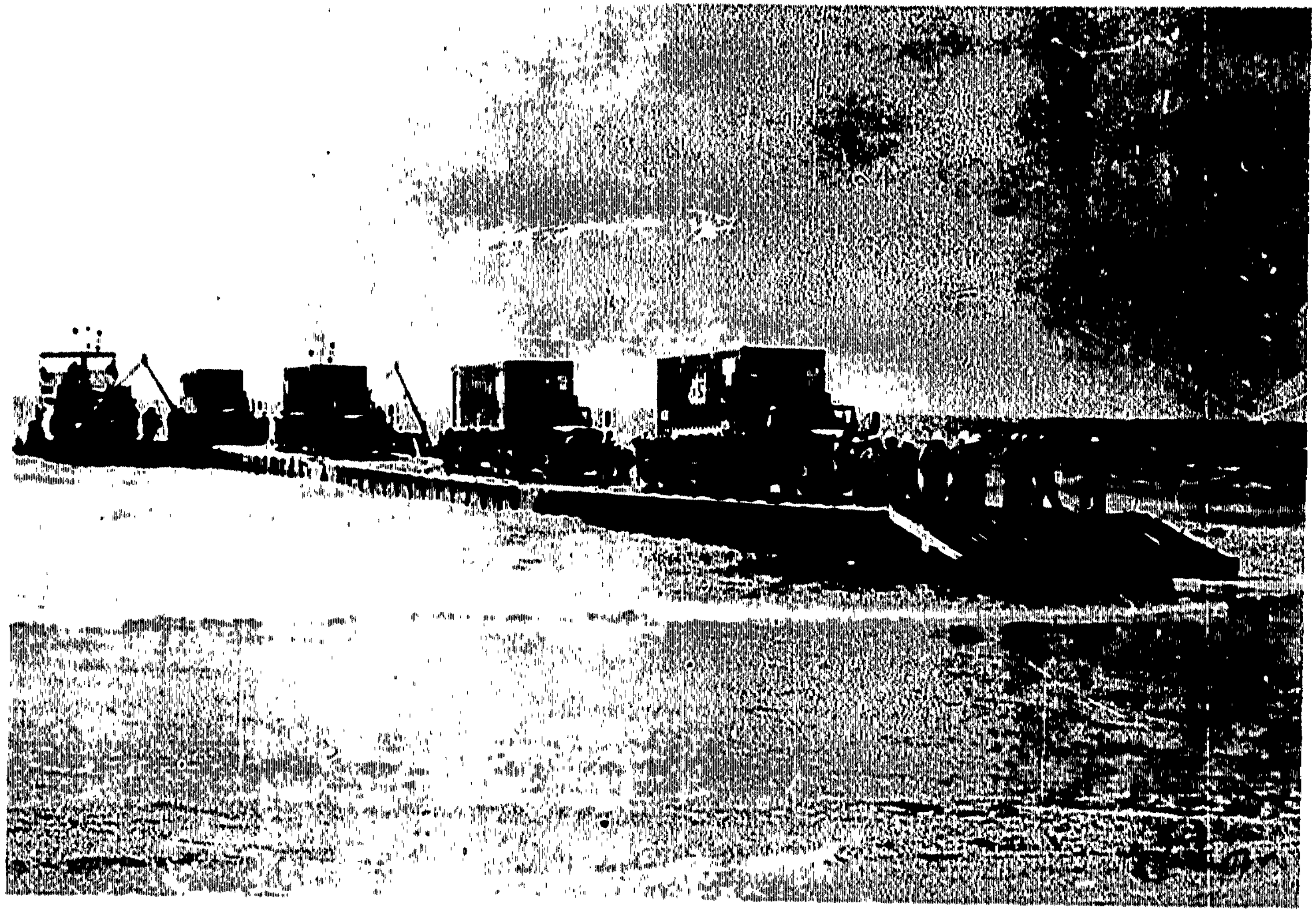


Figure A.18. Direct beaching of 4-section ferry.

Figure A.19. Truck/trailer roll-off onto Mo-Mat.

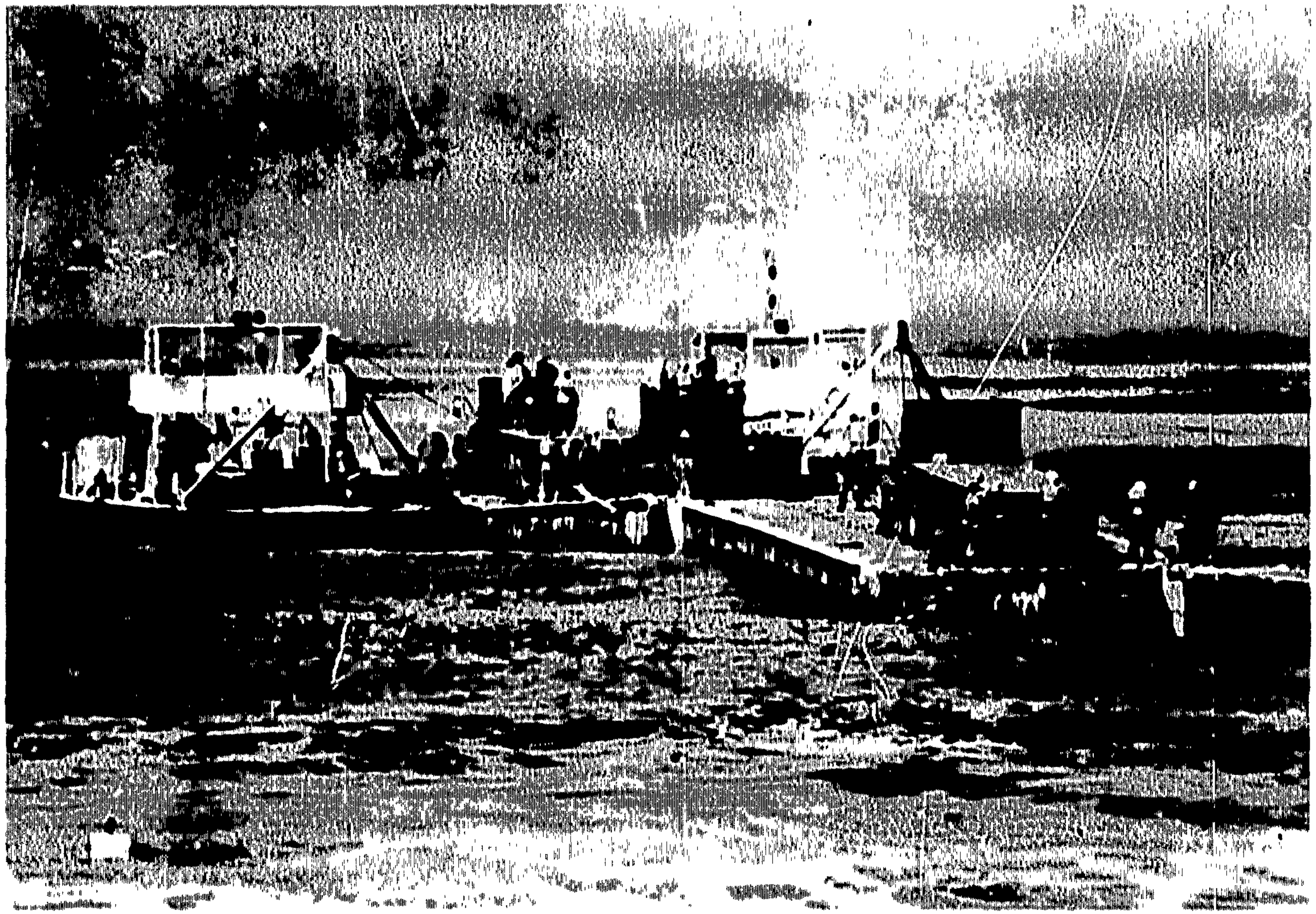


Figure A.20. Driving M52/M127 units across 8-section moored causeway to 3-section ferry.

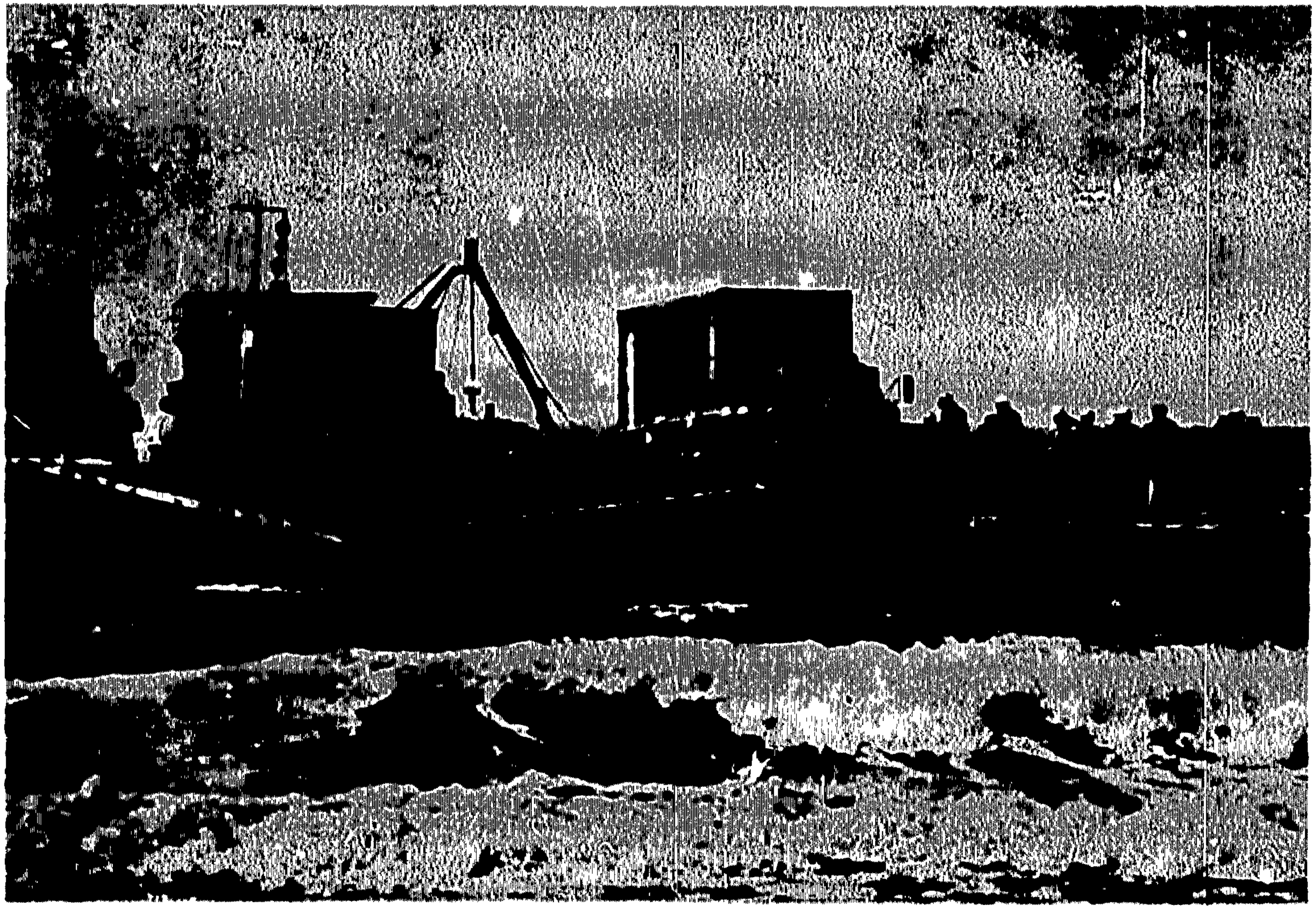


Figure A.21. Three-section ferry approaching 8-section moored causeway in 7-8 foot swells.

Figure A.22. Front lift loader moving container to trailer.

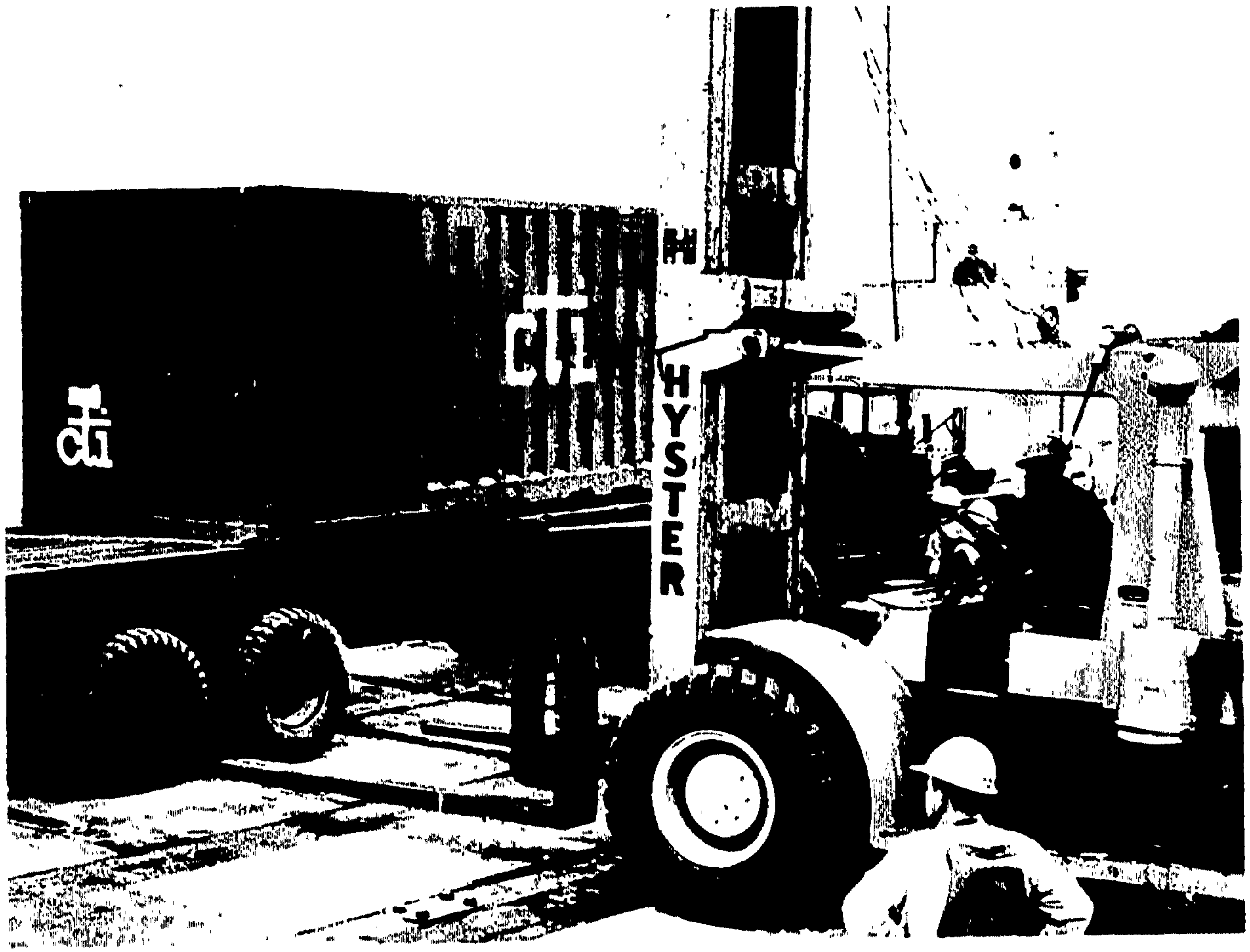


Figure A.23. Front lift loader placing container onto trailer.

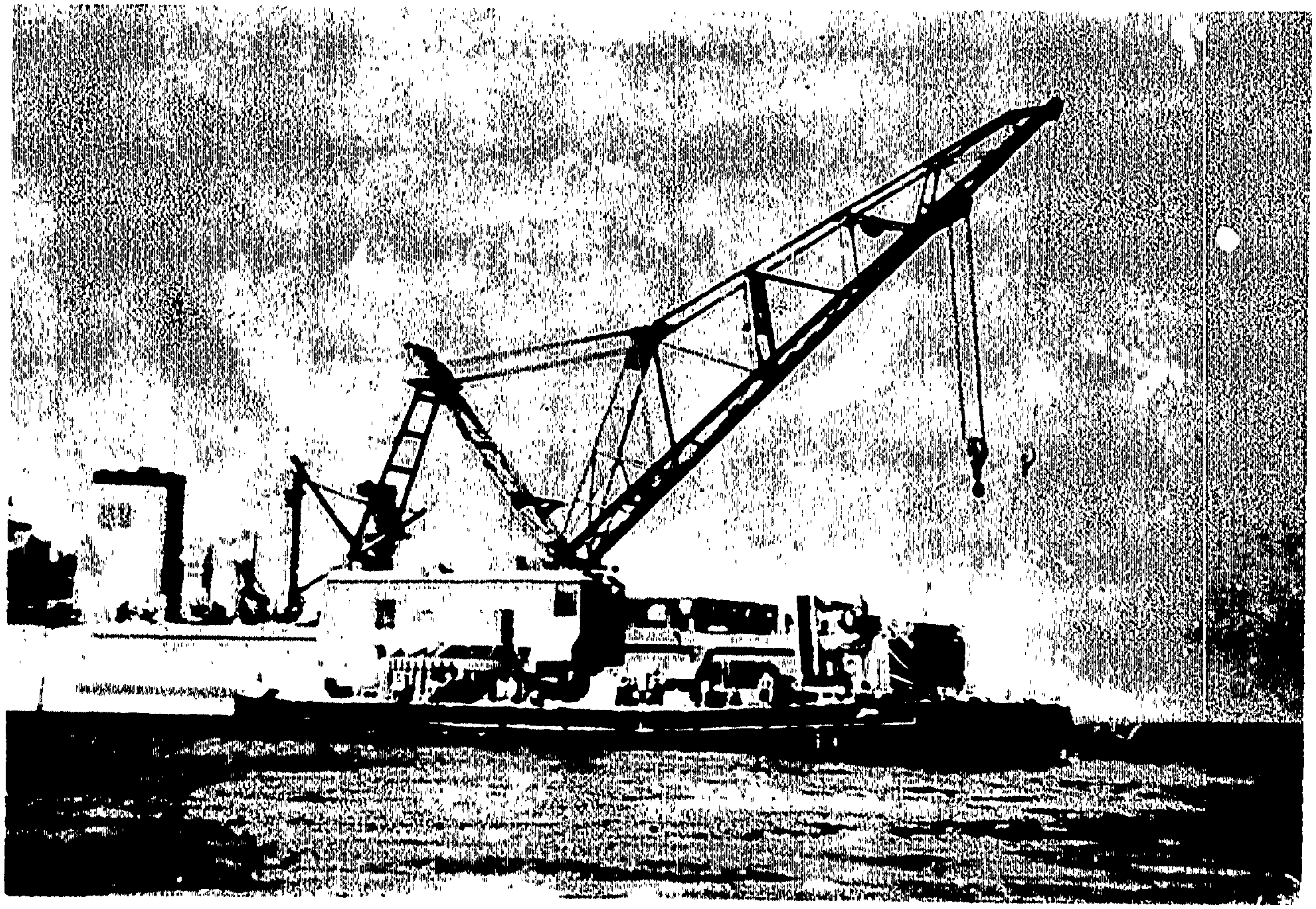


Figure B.1. Navy floating crane, YD 193.

Table B.1. Crane Lift Characteristics

	Lift at Max Radius	Hook Speed	Rotation Speed	Luffing Rate
Aux Hook	16.5T @ 122.5'	79 ft/min	130°/min	104.5' to 55' in 2½ min
Main Hook	84T @ 104.5'	25 ft/min	130°/min	104.5' to 55' in 2½ min

The YD-193 floating crane was moored alongside the LST 1191, Figure 2, to reach the container cell located in the hatch. At this location, the crane was able to reach all containers on the ship with the auxiliary hook. Containers on the ship with a gross weight of 12 tons were handled with the auxiliary hook while containers with a gross weight of 22 tons were handled with the main hook. Only one 22-ton container was lifted from the deck of the crane barge to the 6x15 barge during the operation.

Two days of familiarization operations in the harbor were conducted without incident. Eight 10-ton containers (five deck loaded and three cell loaded) were off-loaded during the first day. All containers were handled with the auxiliary hook. The initial container off loaded on the second day was a 22-ton unit loaded on the deck of the crane barge. The main block was used to handle this container. The remaining six 10-ton containers were off loaded with the auxiliary hook. Fourteen containers, eleven deck loaded and three cell loaded, were backloaded during the afternoon of the second day. A summary of off-loading and backloading times is contained in Tables A.2 and A.3.

The first days operation at sea (21 March 1972) was cancelled because of difficulty in mooring the crane barge to the LST. Crane barge surge motions of about 8 feet coupled with inadequate fendering prompted the postponement of operations. A new mooring configuration and a camel log to supplement the LST's 3-foot diameter rubber fenders were employed the second day.

During the second day's operation, eight 10-ton containers were off loaded. All containers were handled with the auxiliary hook of the crane. Despite maximum relative surge motions of about 8 feet between the crane barge and LST, the containers were off loaded without incident.

The sea conditions appeared worse on the third day than on the previous two days. The same mooring and fendering arrangement was used, however the ship's rubber fenders had deteriorated until they offered little protection and the camel log was ineffective because it continually worked under the LST. This absence of adequate fendering resulted in damage to both the LST and crane barge. Three 10-ton containers were successfully off loaded before the operation was halted. Container off loading times for the open sea operations are summarized in Table A.3.

Discussion. In general, the performance of the YD-193 Navy floating crane at sea was much better than anticipated. The container off loading rate was little degraded from the rates obtained during the harbor operations. The average crane cycle for the eleven containers off loaded at sea was about five minutes, or twelve per hour. Although there were relative heave motions of about 4 feet, the crane operator with deck crew assistance was able to successfully place the spreader bar on the containers and transfer them to the 6x15 barge. The fendering between the LST and crane barge proved to be a limiting factor of the operation.

The success of the open sea operations was in no small part attributable to the expertise and experience of the crane operator and deck crew. Following the operation, the crane operator and deck crew were interviewed to obtain their ideas for improvements to the crane and the overall operation.

Findings. Based on observations during the exercise and comments by the crew, a crane for off loading containers at sea should have the following characteristics:

1. A full circumference (360°) swing without interference.
2. Fast down hook speed to permit spreader placement at an opportune time.
3. Free wheeling capability with the hook so that the load can be controlled by braking. Also, crane should have power down for better load control.
4. Operators cab should be as high as possible to allow operator to observe spreader operations.
5. A signalman should be stationed at pickup and placement locations with a signaling responsibility only.

The crane operator made the following observations with regard to mechanical aids:

1. Guides on two sides of the spreader bar were clearly more helpful than guides on four sides.
2. The cell extension simplified insertion of the spreader bar in the container cell.
3. A spreader bar which allows the operator to drop the spreader directly onto a container with final alignment provided by the spreader would permit operations even with significant relative motions.
4. Power tagline has potential for in and out pendulation control and for load orientation control.

2. Power Tagline

A powered tagline system was installed on the crane to assist in positioning the container and to control load pendulation. It was believed that tagline tension, applied to the spreader/container when suspended from the hook, would retard, control or possibly eliminate load pendulation.

A Morin Motor Driven Type BRHX Dual Tag Master System was installed on the crane (YD-193) by PWC, San Diego. Two Tag Master units with 5 HP, 3 phase 60 cycle, 220/440 volt gear motor mounted on a common base plate were installed at the base of the crane boom, Figure B.2. A chain drive to a 30-tooth sprocket drove the Tag Master units at 85-90 rpm with a resultant line speed of 130 fpm. Air operated controls were mounted convenient to the operator. Line tension was controlled by applying air pressure (100-125 psi) to the Tag Master cylinders. Tension on either tagline could be increased or applied on both lines simultaneously through the two control levers. The Tag Master units were initially adjusted to provide a continuous line pull of 50 pounds. The operator could increase this line tension on either or both lines to 2,000 pounds with the control levers. A check valve in the controls was provided to hold pressure and maintain line tension when the operator released the control levers. The two taglines were run up the crane boom approximately 30 feet and then out to the spreader bar in a 2-part line arrangement. Electrical power and air pressure required to operate the Tag Master units was provided with auxiliary equipment mounted on the crane barge.

The tagline was delivered with a defective air check valve rendering one Tag Master unit inoperable; it was not possible to lock and hold the line tension applied on the unit. A bridle was devised which permitted the use of the remaining Tag Master line with the spreader.

The power tagline was employed primarily to steady the container or spreader/container during transit between the LST and 6x15 barge. The initial tension setting of 50 pounds proved to be a hindrance to the deck crew manning the manual taglines. It was difficult for the crew to overcome the pull of the tagline on the spreader particularily during final positioning of the spreader over a container, into the cell or when positioning the container on the deck of the 6x15 barge. It was necessary to adust the line tension several times during the operation until a tension of about 15 to 25 pounds was established. The power tagline was deactivated when final positioning the spreader or container was required. It was noted that the electric motor overheated during prolonged used under maximum tension. The crane/powered tagline combination is pictured in Figure B.3.

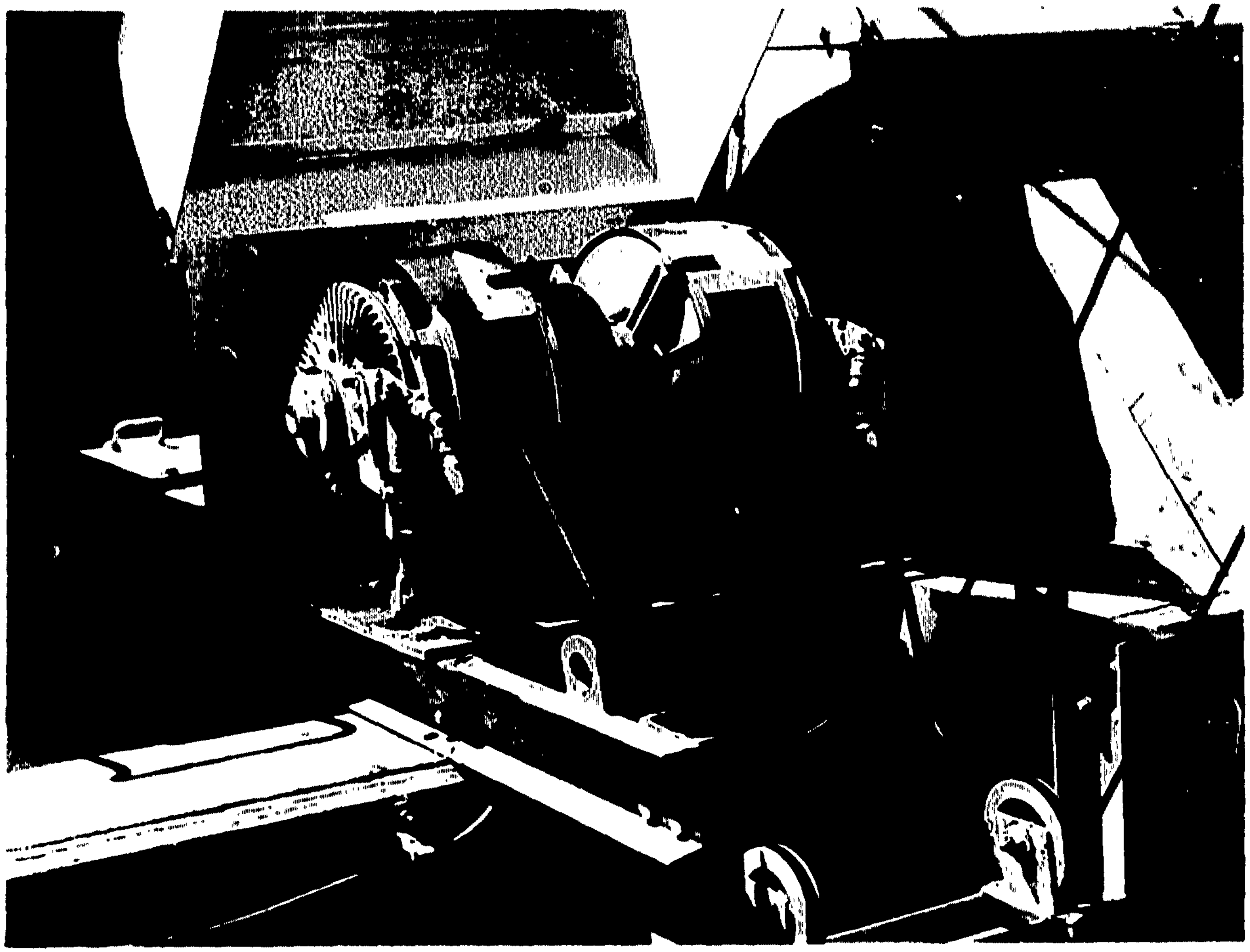


Figure B.2. Powered tagline system on crane.

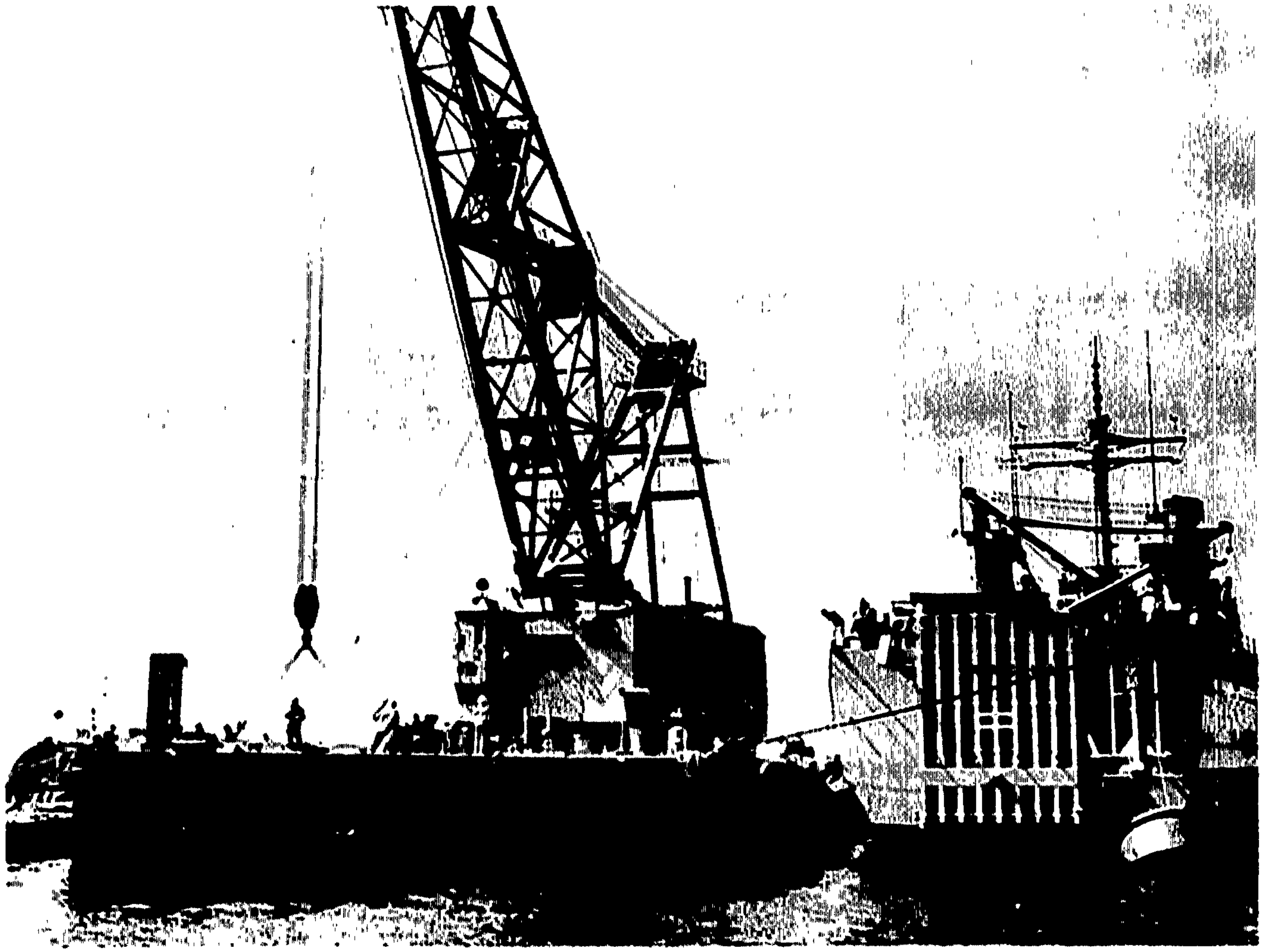


Figure B.3. Powered tagline system on crane.

Findings and Recommendations. Discussions with the crane operator and rigging crew indicated that the tagline provided assistance to the tagline crew during the transfer phase, steadied the container in the wind, and provided a dampening effect on the pendulation. Based on the observed results of the operation and interviews with the crane operator and rigging crew, the following is recommended:

a. Provide a larger (7.5 HP) electric motor for the unit.

b. Correlate specific control positions with specific line tensions for the convenience of the crane operator.

c. Strengthen the sheaves and other miscellaneous fittings associated with the unit.

d. Provide adequate training time for the operator to become familiar with the operation characteristics of the Tag Master unit.

3. Spreader Bar

A 20-foot single point suspension, manually operated spreader capable of handling any nominal 20-foot ANSI/ISO container with a maximum gross weight of 44,800 pounds was used in the operation. The spreader, nominally 20-feet long by 8 feet wide weighed approximately 2,600 pounds. The spreader had six bolt-on aligning arms, two on each long side and one on each short side. Twist locks on the four corners were manually locked and unlocked with a lever arm located at the center of the long side of the spreader. Padeyes were located on each corner to accommodate both hand-held and powered taglines. The spreader bar is shown in Figure B.4.

The first four deck-loaded containers were removed with the spreader bar guided on all four sides. Some difficulty, with resulting time loss, was noted in aligning the spreader over the container prior to engagement. The opening on the spreader when guided on all four sides is approximately one-foot larger than the container. This restricting opening requires rather precise alignment of the spreader over the container. Any motion of the crane platform with resulting spreader pendulation makes positioning of the spreader on the container a difficult task.

The second lift series of four containers included three containers stowed in the container cell located in the hatch of the LST. It was necessary to remove the guides from the spreader to permit entry into the cell. Little difficulty was experienced in placing the spreader into the cell and engaging with the container. Minor binding occurred while extracting the middle container from the cell, but did not slow the operation. During the extraction of the bottom container, the twist lock lever arm on the spreader hung on the side of the cell shearing the bolt securing the lever arm to the shaft. The twist locks, however, remained secured in the container. The bolt was immediately replaced with no further problems.

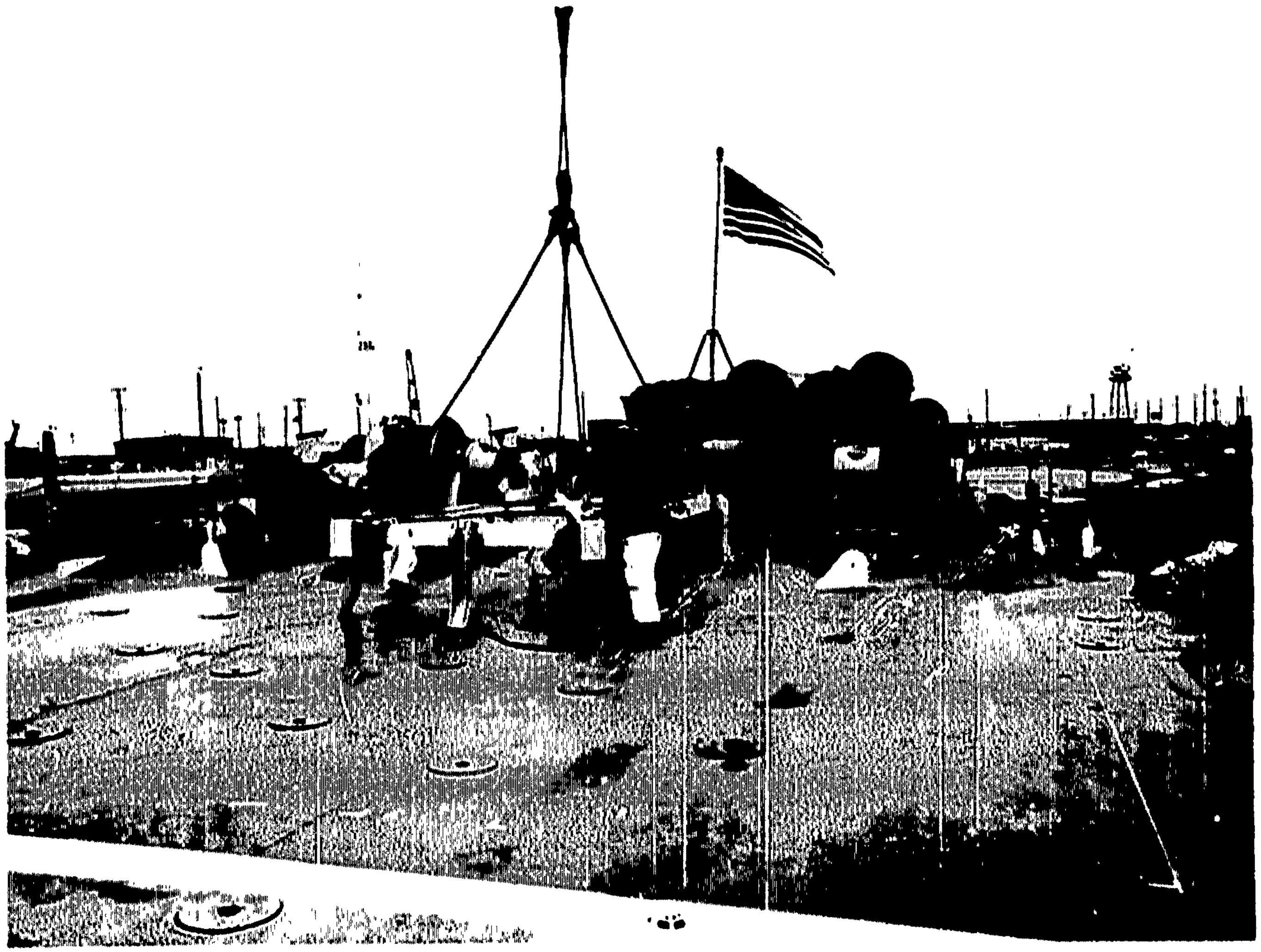


Figure B.4. Spreader bar guided on four sides.

To help relieve the difficulty noted earlier while positioning the spreader over the deck-loaded containers, three of the six guides were moved from the spreader, see Figure B.5. With the spreader now guided on only two sides, near long and right short, the crane operator was able to swing the spreader over the container and bring the guides to bear against the sides of the container, see Figure B.6. Once the guides were in contact with the container sides, the spreader was quickly lowered the remaining distance to engage and lock the twist locks into the corner fittings of the container. The remaining deck loaded containers were off loaded using the spreader as modified. Guiding the spreader on one, two sides simplified the spreader placement operation with a resultant reduction in spreader placement time.

A relative surge of approximately 8 feet between the crane barge and LST was experienced during the first day's operation in the open sea. No serious problems were noted in placing the spreader over the deck loaded containers or in placing the spreader into the cell. Providing guides on only two sides of the spreader proved very effective in positioning the spreader and securing it to the container.

During the second day's operation in the open sea, a relative surge of about 8 feet combined with a relative vertical displacement of about 3 to 4 feet increased the problems and hazards associated with the operation. Again, the spreader with guides on only two sides proved very effective in positioning, holding and securing the spreader to the container. The average time required to position and lock the spreader to the container was less during the open sea operation than during the harbor operation.

An examination of eight containers at the completion of the operation showed no damage attributable to the spreader twist locks or guides.

Findings and Recommendations. Base on the results of the test, observation of the evaluation and interviews with the crane operator and riggers, the following are recommended for the manual spreader used during these tests:

a. Install guides on only two sides of the spreader when off loading deck loaded containers.

b. Place an additional guide (total of two) on the short side of the spreader.

c. Provide longer (6-12 inches) and stiffer guides on the spreader.

d. Provide hand held taglines of sufficient length to reach from the deck of the containership to the deck of the crane platform.

e. Provide a five man crew, four ling handlers and one signalman, at each area where manual taglines are to be employed to control the spreader/container.

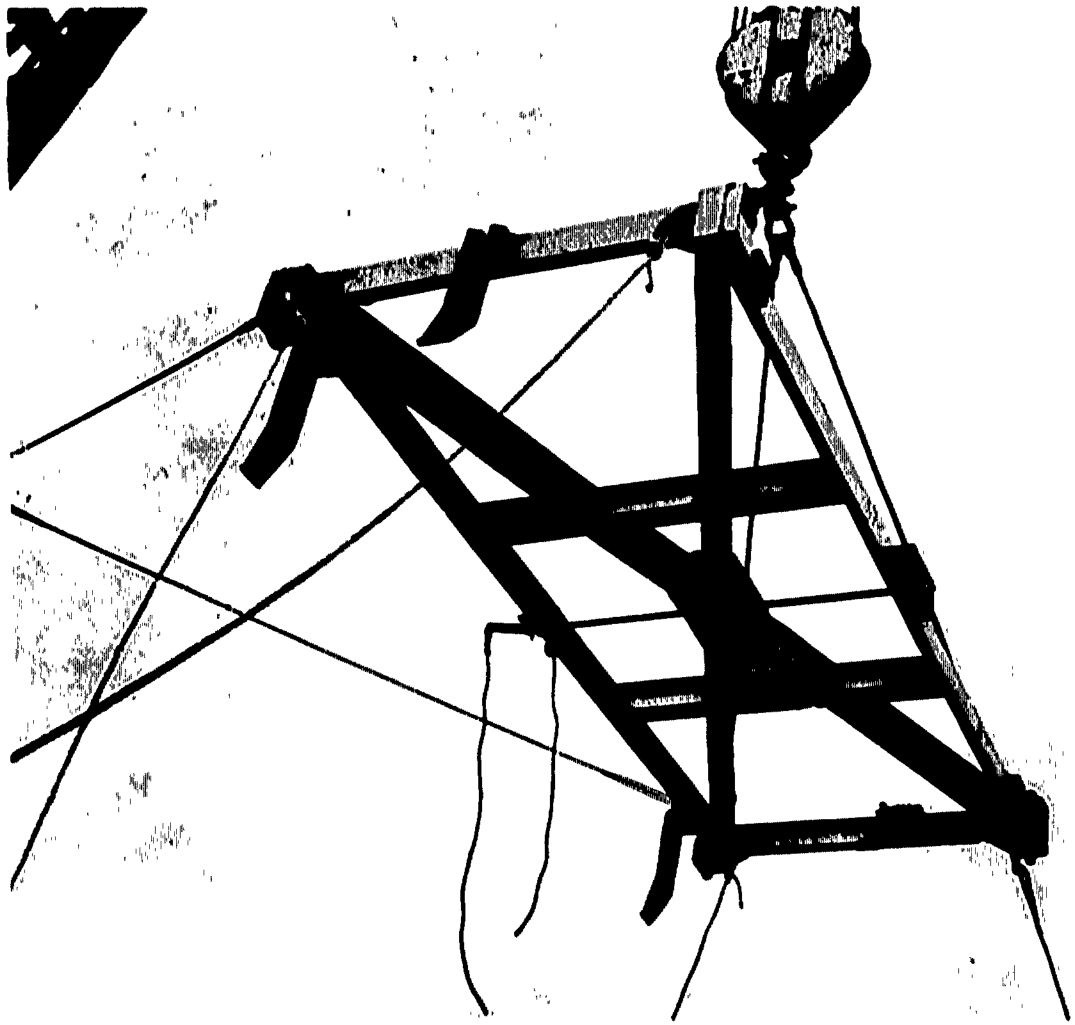


Figure B.5. Spreader bar guided on two sides.

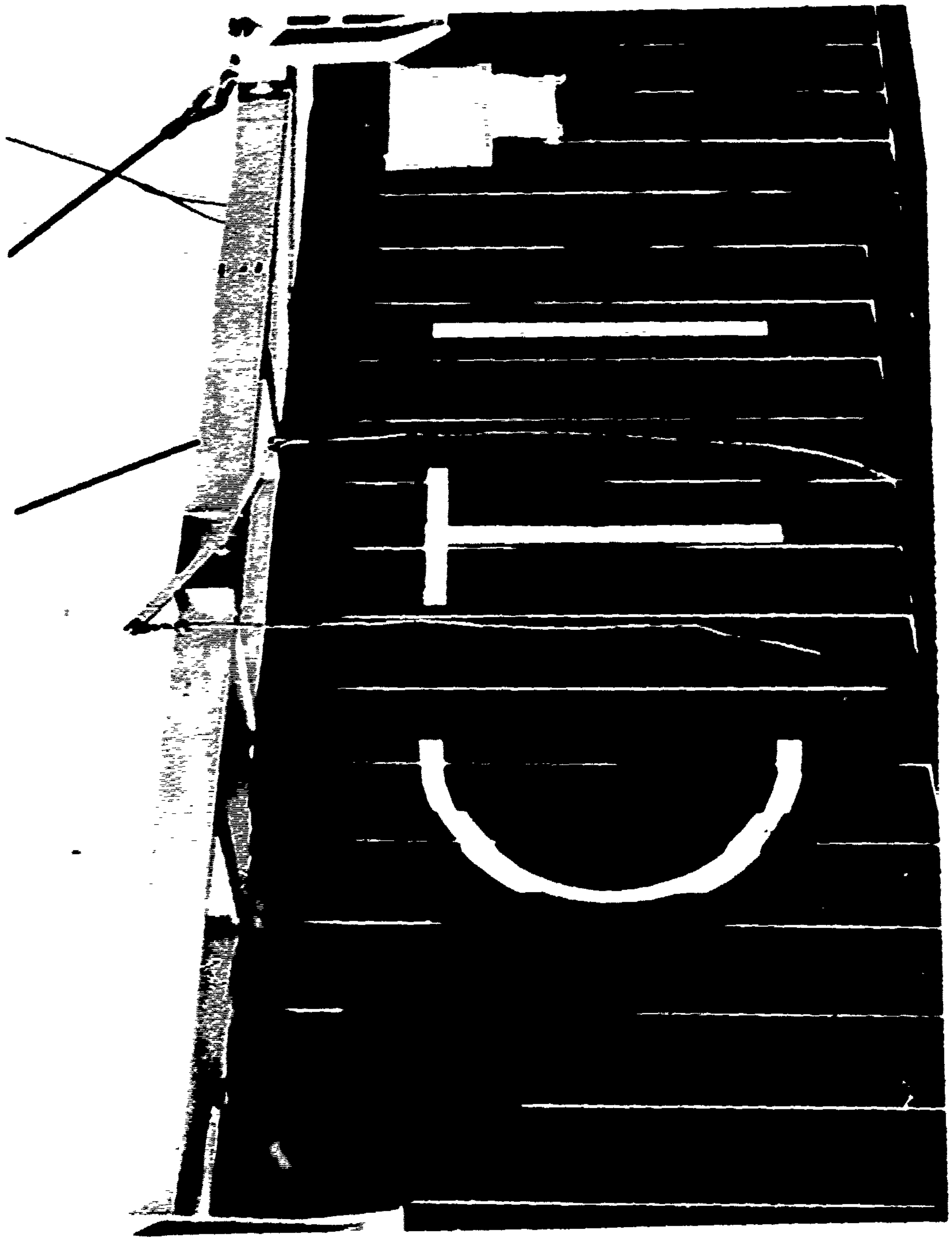


Figure B.6. Spreader bar being positioned on container.

Based on the observations made during the tests an improved spreader for OSDOC II should be provided with the following:

a. Self-leveling capability.

b. A flat, unobstructed bottom surface for contact with the top of the container.

c. Retractable guides for final alignment of spreader on container.

d. Retractable twist locks.

C. BEACH COMPONENTS

1. Mo-Mat

The beach hardening material or Mo-Mat was supplied by ACB-ONE and was placed on the sand from the end of the beached causeway ferry, up the 4 to 17 degree beach slope to the hardstand area, a distance of 70-80 feet. Mo-Mat is fabricated from fiberglass-reinforced plastic with a non-skid material bonded to the top surface. It is molded into a structural shape resembling a waffle having a material thickness of .085 or .127 inches and an overall thickness of 5/8-inch. The material is supplied in standard sheets 12 feet wide by 50 feet long which can be bolted together to form longer sections.

The truck/trailers (M52/M127) units were empty while driving down the beach slope and carried the 24,800-pound containers up the beach slope. Sometimes Mo-Mat developed a wave between the trucks' front and rear wheels, but it flattened out without damage. This material operated satisfactorily during the tests. See Figures C.1 and C.2.

2. On-Fast

On-Fast is an expedient surfacing material for use on soils. The composition of On-Fast is fiberglass filled with polyester resin.

In order for the resin to cure quickly (within 30 minutes), it is catalyzed by means of emulisified benzoyl peroxide and promoted by means of dimethylaniline. The amount of catalyst and promoter each range up to about 1% by weight of resin. Since the catalyst emulsion presently in use contains 40% benzoyl peroxide, the amount of emulsion required to provide 1% benzoyl peroxide is 2.5% by weight of resin.

The resin system is applied to the fiberglass (previously placed on the soil) by means of a Manual Spray Unit (MSU). (Figure C.3) The MSU contains separate pumps for each of the three liquid components. The resin pump forces resin into two separate line of equal capacity. The catalyst is forced into one of these lines; the promoter is forced into the other line. A hand-held double nozzle spray bar is attached to the two lines by means of flexible hoses up to 50 feet in length. The catalyzed resin exits from one nozzle and the promoter-resin exits

from the second nozzle. The two V-shaped fan sprays intersect about 15 inches from the nozzle where blending of the liquid components begins. Further blending occurs with overlapping passes of the spray on the fiberglass. This material system can be applied at a rate exceeding 1,000 square feet per hour. It is ready to use within 30 minutes after application. The fiberglass consists of chopped fibrous glass strands unwoven, randomly distributed and bonded with high solubility binder to form uniformly thick glass mats.

The MSU plumbing system is cleaned by pumping methylene chloride utilizing all three pumps and spraying until clear methylene chloride exits from the nozzles. Methylene chloride is a non-flammable, highly evaporative solvent.

There are certain inherent risks to personnel in handling and disposing of the catalyst and the promoter. The latter, dimethylaniline is highly toxic. Any potential user should become thoroughly familiar with the hazards of these materials before using them. There is very little risk involved if the user is careful and properly trained.

Materials in place cost about $1.00 per square foot if 6 ounce per square foot fiberglass is used. If 2 ounces of fiberglass are used the cost is reduced to about $0.34 per square foot.

<u>Green Beach Application</u>. On March 7 and 8, 1972, two MUS's, each mounted on cargo trucks with supplies of resin, catalyst and promoter, were used to apply approximately 13,000 square feet of usable area of On-Fast. Two crews of 6 men each from ACB-ONE (personnel of Charlie Company and Beach Bravo) constituted the man power requirements.

A bulldozer with free-floating blade backed along the beach beginning at the near edge of an existent pade of AM-2 matting, (Figure C.4) This left a smooth surface over which fiberglass (11.5 feet wide, 6 ounce per square foot) was unrolled and overlapping the AM-2 matting by about 5 inches. Each truck was about 25 feet in from the side boundaries, headed tward land, so that each crew could apply resin to half of each strip of fiberglass (each strip had a gross length of 105 feet) (Figure C.5)

For the second strip of glass, the bulldozer again smoothed the sand surface. The windrow of sand left by the bulldozer adjacent to the first strip of On-Fast was smoothed out by hand using shovels and brooms. The second strip of glass overlapped the first by about 10 inches. The operation progressed in this fashion until the hardstand was completed to about 100 feet by 100 feet net. (Figure C.6)

A roadway from the On-Fast pad to Silver Strand Boulevard was also fabricated using a single strip of fiberglass 11.5 feet wide. (Figure C.7)

The sand adjacent to the On-Fast had an average in-place dry density of 99.3 pounds per cubic foot and a moisture content of 1.7% with very little variation among 5 sets of measurements by means of a nuclear moisture-density meter.

Figure C.1. Mo-Mat laid from ferry ramp to hardstand.

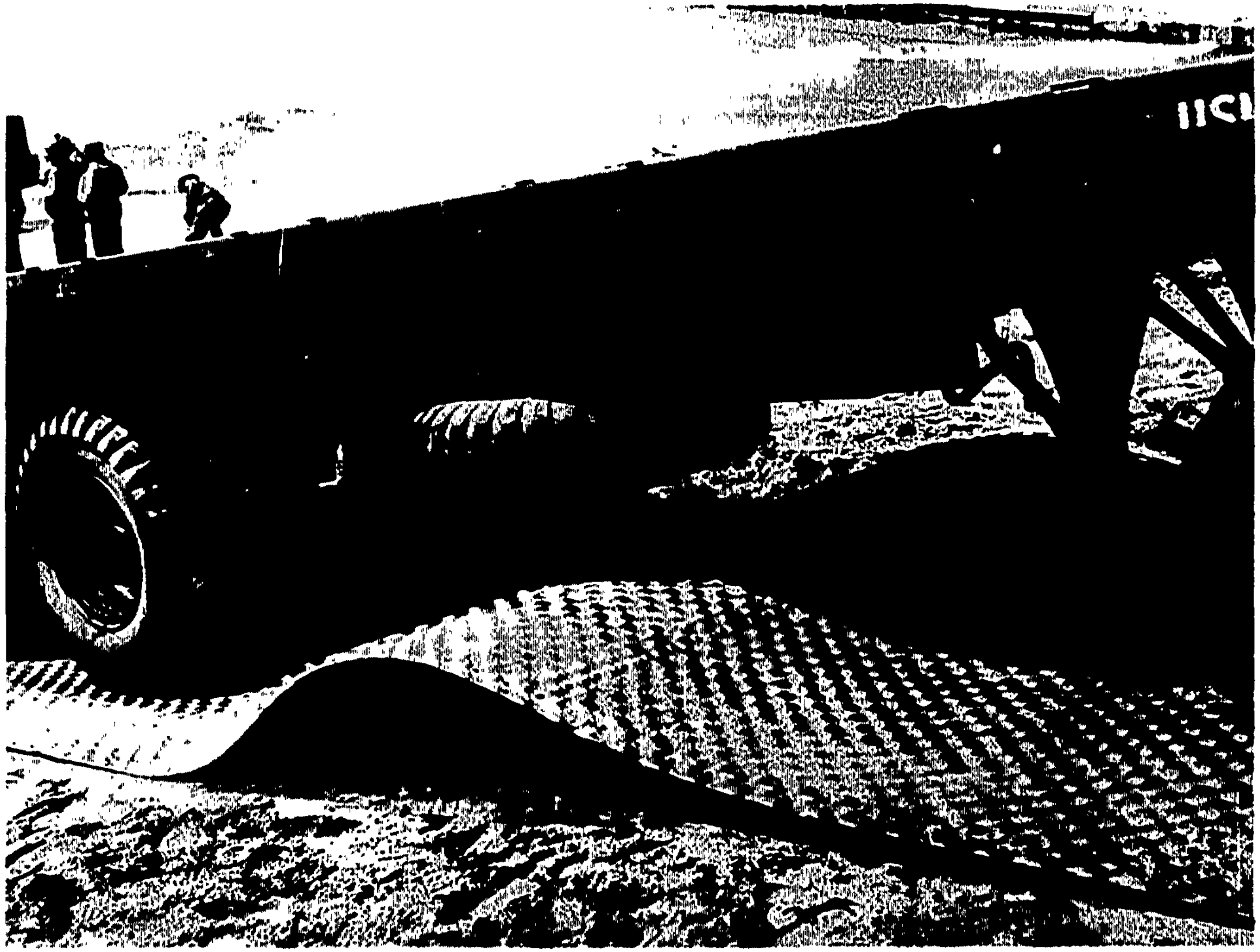


Figure C.2. Wave developed by trailer wheels on Mo-Mat.

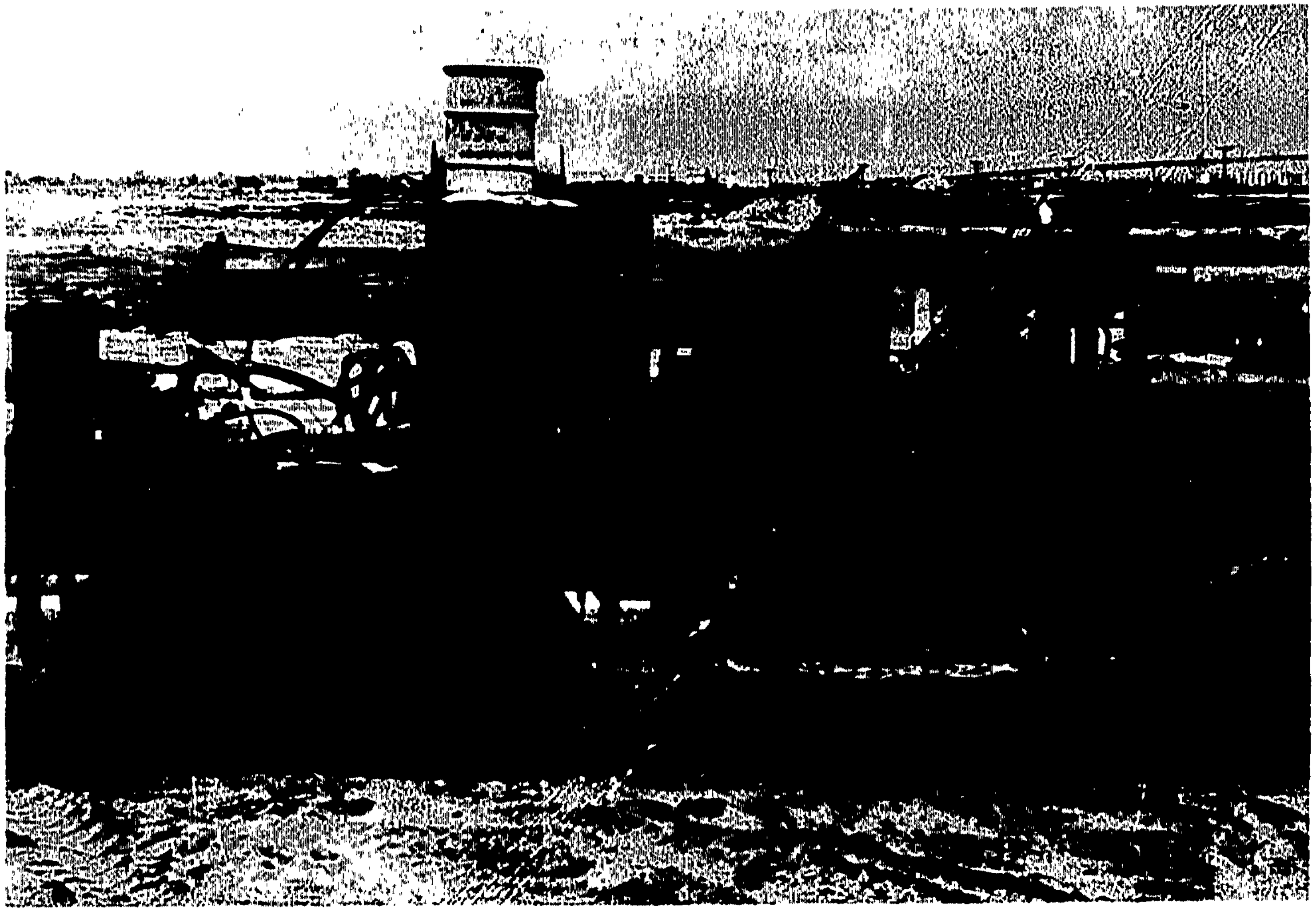


Figure C.3. On-Fast spray equipment.

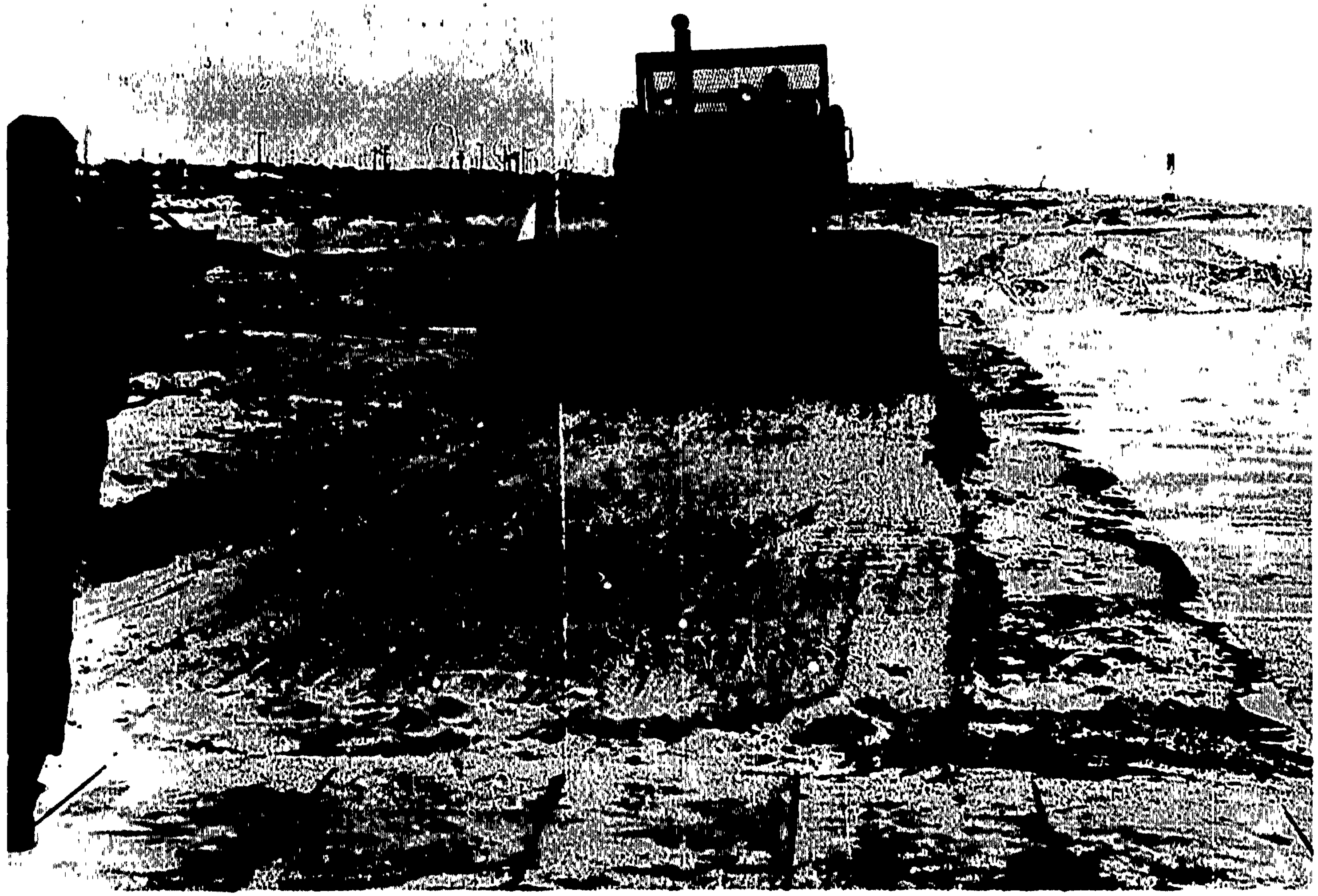


Figure C.4. Back blading sand prior to installing On-Fast.

Figure C.5. Installing On-Fast hardstand area.

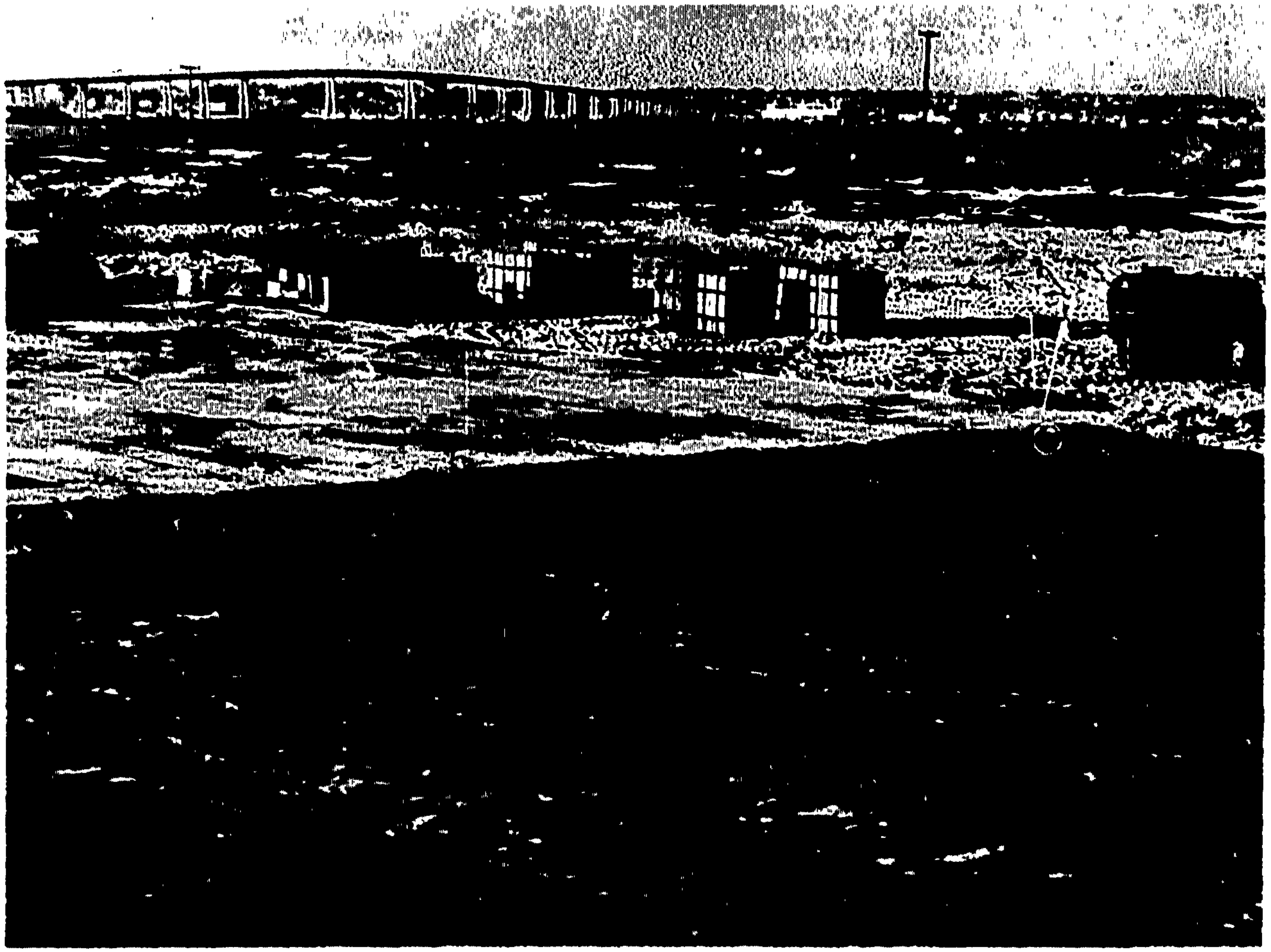


Figure C.6. On-Fast hardstand installed adjacent to AM-2 mat.

Figure C.7. On-Fast entrance roadway.

Performance. During the cargo operations, M52A truck/trailers combined with M127 semi-trailers were used to haul containerized loads. Gross load was as follows for each loaded mobile unit:

Unit	Weight, lbs
M52A	19,456
M127	14,460
Container	4,400
Container Contents	20,000
Gross Load	58,316

A 4 by 8 mobile crane (35 ton capacity) weighing 68,500 pounds was operated across the On-Fast and stationed on the AM-2 matting. All of the above vehicles were brought in by or exited by the On-Fast roadway.

Vehicle traffic over the On-Fast consisted of the following:

21 March: 12 empty M52/M127 (each weighing 33,916 pounds) units crossed over the On-Fast.

22 March: 8 empty M52/M127 units crossed over enroute to the sea.

8 loaded M52/M127 (each weighing 58,316 pounds) units returned from sea and crossed over the On-Fast to unloading area.

1 loaded M52/M127 (weighing 78,316 pounds) entered from the On-Fast roadway, circled on the On-Fast material and exited via the On-Fast roadway.

23 March: 3 empty M52/M127 units crossed over enroute to the sea.

8 empty M52/M127 units crossed over enroute to the unloading area.

8 loaded M52/M127 (each weighing 58,316 pounds) units crossed over enroute to the shore.

The mobile crane and an unknown number of smaller vehicles also crossed over the On-Fast material at various times.

Some minor damage to the roadway occurred when a 44,800 pound container was brought in on an M52A/M217 combination with a total gross load of 78,316 pounds. This vehicle generated a bow wave in

the ribbon of roadway. The rear wheels overtook and ran over the wave of On-Fast and cracked it transverse to the roadway.

The roadway handled all of the traffic even after being damaged as above noted. The last large vehicle out was the 35-ton crane. The roadway was not anchored. Had it been anchored, the bow wave would not have developed.

No damage attributable to traffic occurred on the 100 foot by 100 foot On-Fast pad. It was expected that some shearing action of the On-Fast might have occurred where the On-Fast overlapped the AM-2 matting; however, such was not the case.

Mo-Mat was used between the On-Fast pad and the temporary causeway and between the AM-2 matting and the fixed causeway. The Mo-Mat served the purpose adequately; however, the trucks also generated bow waves in this material. It cracked transversely when the vehicle ran over the bow wave.

The On-Fast pad served its purpose exceptionally well. The roadway was not intended to serve the severe traffic it received; however, it too held up quite well and was still serviceable at the close of operations. The inconsequential damage to the roadway could have been repaired and useable within 30 minutes had a MSU and supply materials been on hand for this purpose. The roadway served an unexpected function. It made it possible for an ambulance to pick up an injured man at the pad site.

3. AM-2 Mat

This standard aluminum airfield mat was installed on the dry beach sand after a minimum of back blading with a tractor. No apparent damage resulted from driving and turning the loaded truck/trailer (M52/M127) units on the AM-2 mat and no damage occurred as a result of positioning the 35-ton capacity mobile crane on the mat and unloading the containers from the trailers.

D. ANCILLARY EQUIPMENT

1. Container Cell

The container cell (Figure D.1), fabricated from structural steel angles, was provided to simulate the operations of removing containers from a containership cell. The cell stood 26 feet high with inside plan dimensions of 20'-0" by 8'-1" providing 1½ inches and 1 inch clearance between a standard container in the long and short directions, respectively. Flares at the top of the cell (Figure D.2) provide about 6-8 inches greater width as a target for fitting a container into the cell. Extensions were bolted atop the cell to determine if they aided the placement of containers in the cell. The 18-inch extensions

(Figure D.2) were place along only two sides of the cell to allow the spreader bar to swing into an open corner, rather than dropping the spreader into a limited opening at the top of the cell. The cell sat on a steel beam base in the tank deck of the LST. The base, which was designed to distribute the container weight to the ship's structural members, is shown being installed in Figure D.3. The base was bolted to cloverleafs on the main deck by the ship's vehicle tie-down gear as shown in Figure D.2.

Tests. Three containers were transferred from the cell to the deck and back again during the harbor operations. The cell extensions were not attached to the cell during this operation. Table D.1 lists the recorded times to perform the sequence of operations for extracting a container from the cell. The times include operations from when the spreader is above the cell until the container is lifted clear of the cell. The average time to remove one container was 4 minutes 41 seconds in the harbor.

On 16 March the three containers were backloaded into the cell, this time with the cell extensions in place. Average time for backloading one container (container above cell to spreader clear of the cell was 2 minutes 56 seconds. The operational times are listed in Table D.2. Figure D.4 shows a container being lowered into the cell.

During operations at sea, three containers were transferred from the cell to the LST deck with the cell extensions in place. Average time to insert spreader and remove one container was 2 minutes and 54 seconds. Recorded operational times are given in Table D.1. In one case the spreader bar titled lengthwise in the cell as it was being lowered. The cell was blocked from the crane operators view by deck loaded containers and the operator had to depend upon signals from one of the riggers on the deck. Containers were not backloaded to the cell at sea.

The container cell served its intended function of simulating cell operations on a containership. The cell extensions apparently assisted the insertion of the spreader into the cell based on the shorter in and out time when the extensions were used; however, the crane operator had gained considerable experience by this time. A good comparison of the performance of the extensions would have been to remove the containers from the cell without the extensions and under similar conditions; however, existing circumstances at sea did not permit such a test. The crane operator commented that the cell extensions were a significant aid in placement of the spreader. The tilting of the spreader bar while lowering it in the cell indicated that the longidutinal clearance of 1½ inches may have been excessive. Possibly, one inch all around would be better.

Developing lightweight cell extension devices that can be easily and quickly attached to standard containership cells by one or two men appears to be warranted.

Figure D.1. Container cell frame ready for installation on LST.

Figure D.2. Cell frame positioned on base on LST tank deck.

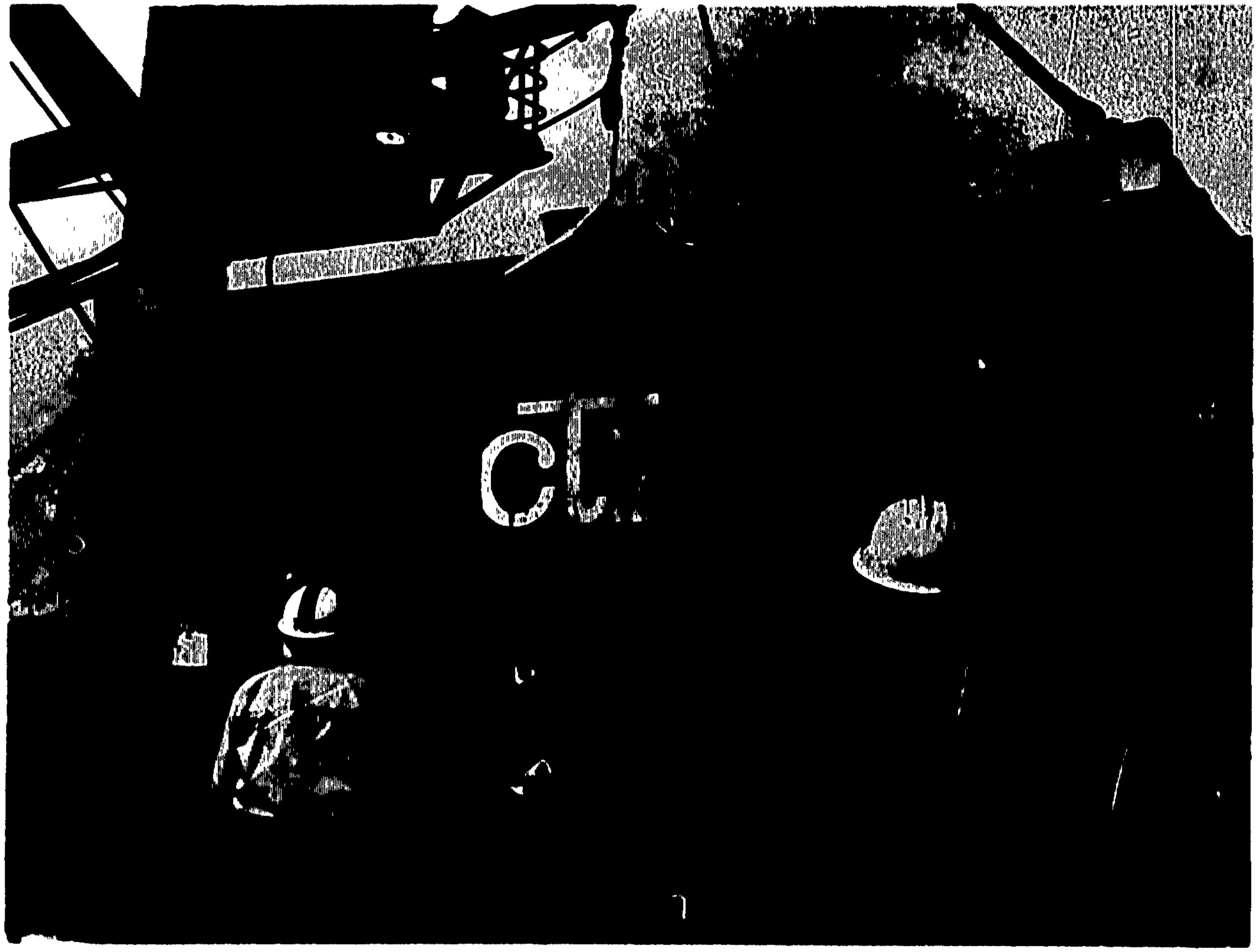


Figure D.3. Loading container into cell during harbor loading operation.

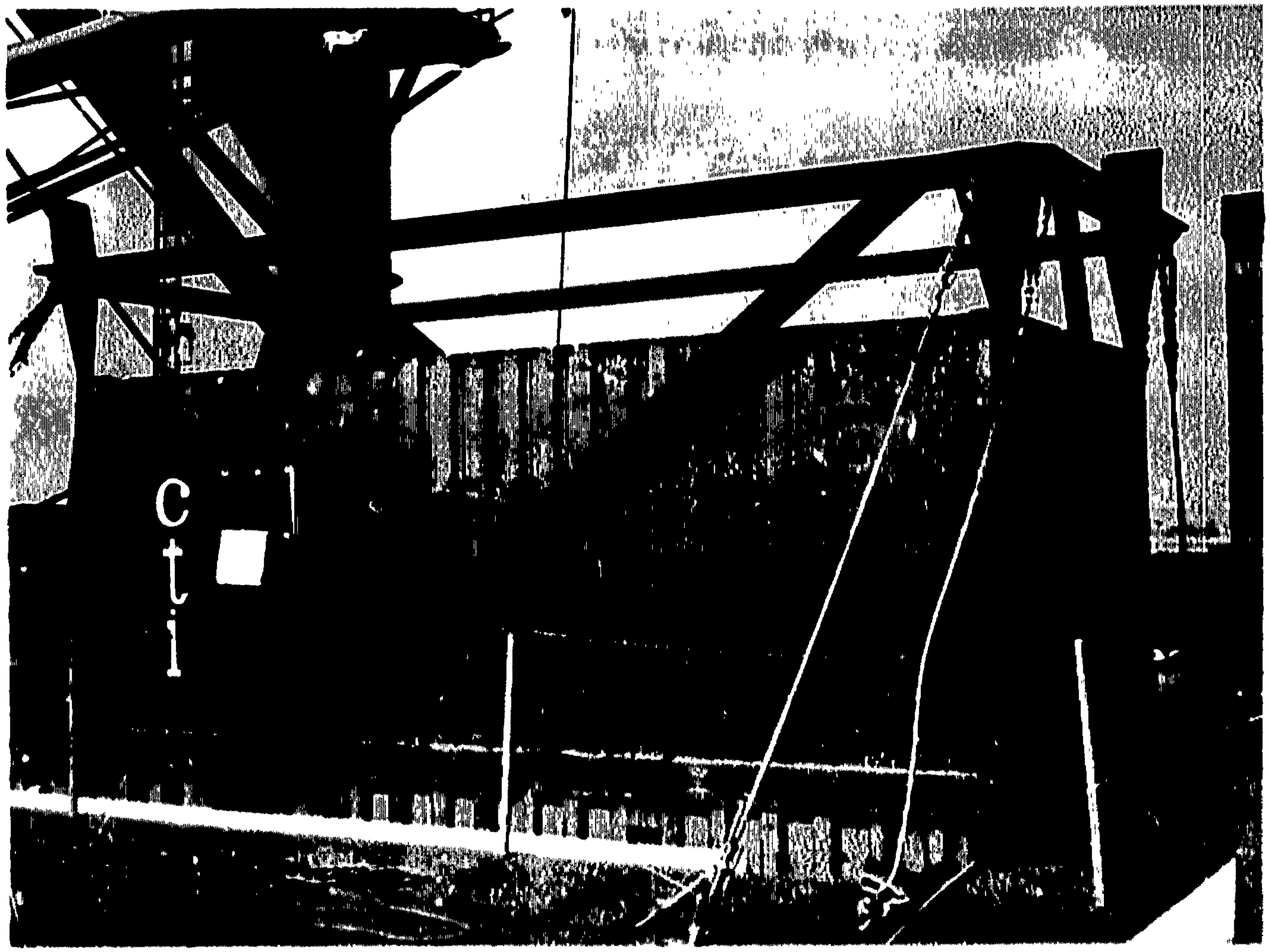


Figure D.4. Three containers loaded into the cell.

Table D.1. Summary of Times for Extraction of Containers from the Cell (min)

Event \ Container No.	Harbor Operations H3	H2	H1	Offshore Operations H1	H2	H3
Spreader over cell to inside flares	3.7	0.9	0.9	0.8	0.5	1.4
Inside flares to contact container	0.1	1.0	0.9	0.1	0.2	0.5
Engage twist locks	1.4	0.1	0.4	0.3	0.3	0.7
Container pickup to clear of cell	1.1	1.7	1.9	1.3	0.9	1.8
Total Time	6.3	3.7	4.1	2.5	1.9	4.4

Table D.2. Summary of Times (min) to Insert Containers into the Cell (harbor operations only)

Event	H1	H2	H3
Container over cell to inside flares	0.6	0.8	0.8
Inside flares to contact	1.5	0.9	0.4
Disengage twist locks	0.1	0.1	0.1
Spreader clear of cell	0.1	0.3	0.1
Total Time	2.9	2.1	1.4

2. Truck/Trailers

The truck/trailer equipmen. were M52A tractors with M127A1 semi-trailers. The M52A weights 19,456 pounds and the M127A1, 14,460 pounds. The overall length of the M52/M127 combination was about 42 feet. The rated load capacity of the trailer is 36,000 pounds on paved roads and 24,000 pounds cross country. These equipments performed satisfactorily on the causeways, Mo-Mat and on the hardstand areas. The 44,800-pound container was transported without difficulty. The M52/M127 units with 24,800-pound containers were driven on Mo-Mat up the 4 to 17 degree beach slope. A wave developed in the Mo-Mat but gave no problem as the wave flattened out at the loose end.

The empty truck/trailers were loaded over the 8-section moored causeway onto the 3-section ferry without difficulty. Waves were 5-6 feet high and observers noted that the vehicles' weight tended to reduce the motions of the causeway sections. It was the observer's opinion that no difficulty would be encountered in driving the vehicles over the causeway in 7-9 foot waves. Backing and maneuvering of the vehicles on the ferries and positioning two truck/trailers side by side was accomplished during the tests. It was noted that the protruding A6 bolt heads on the causeway caused undue wear on the vehicle tires. Two flat tires were attributed to projections on the ferries. The vehicles should be driven only on the pontoon deck and not on the pontoon angles.

3. Vacuum Pads

A part of the engineering tests was to determine the feasibility of securing the 6x15 barge to the ship with a number of large vacuum pads. These pads were to be hung over the side of the ship three to four feet above the deck of the 6x15 barge, suction applied through the pads to the ship's hull, and lines secured from the pad to the barge as a means of restricting yaw and sway. Conventional spring lines were intended to absorb surge, since the holding power of the vacuum pads decreases as the angle of the pull decreases.

The pads, 20,000-pound capacity, were obtained from the Thompson Vacuum Company, Sarasota, Florida. Each pad was composed of a steel plate, 32 inches by 46 inches, with a heavy neoprene seal bolted around the perimeter. Each pad weighed 110 pounds. The vacuum supply was provided by a 1½ horsepower, 115 volt, single phase motor driving a vacuum pump connected to a 21 cubic foot tank. A manifold connected to the tank held five control valves which provided individual vacuum control to each pad.

The plan was to use five of the 20,000-pound capacity units to hold the 6x15 barge. But on-site changes in operational procedures coupled with electrical problems associated with the ship's power supply precluded testing the vacuum pad concept. The units are pictured in Figures D.5 and D.6.

Figure D.5. Vacuum pump with manifold.

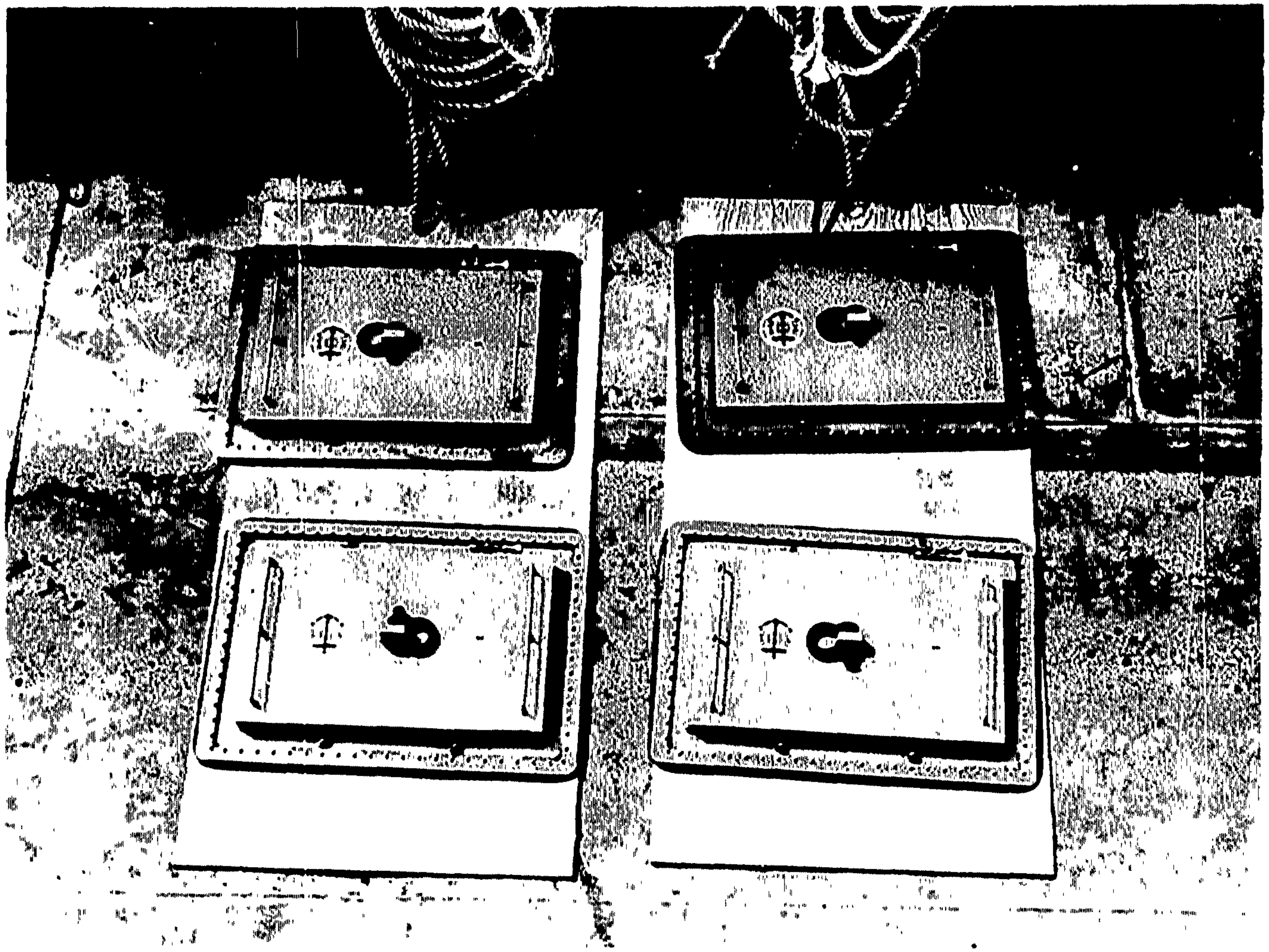


Figure D.6. 3'x4' vacuum pads intended for tieing barge to LST.

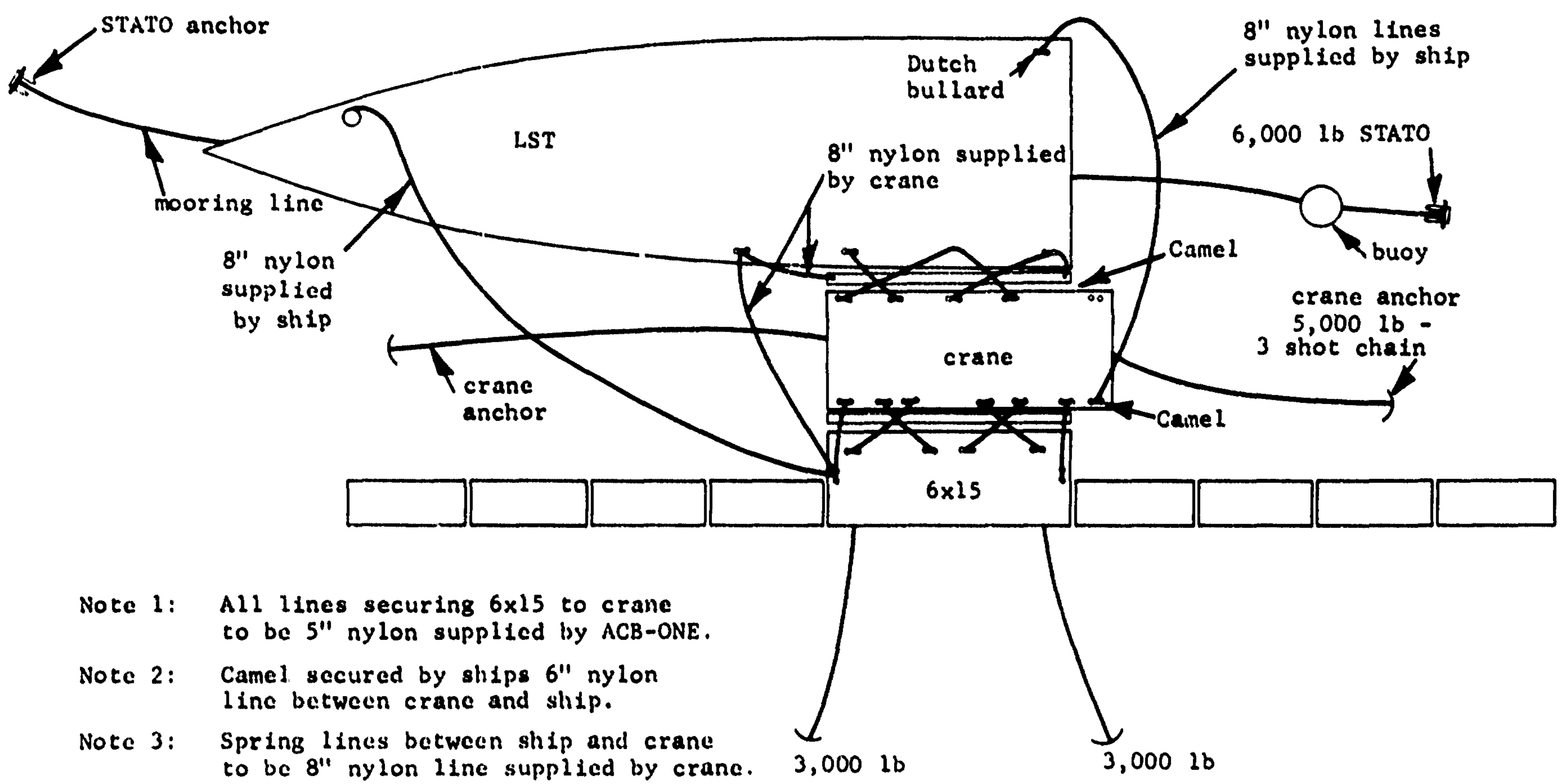
4. Containership

The LST 1191 was provided to carry the containers on the deck and to hold the container cell in its hatch area. Plywood sheets were placed on the deck under the containers to distribute the container weight and to relieve the load concentration caused by the small corner fittings. During the at-sea tests the ship dropped its 18,000-pound bow anchor and together with the preset stern anchor held position with no apparent movement in surge or heave. The operation of this ship was satisfactory for the assigned mission, however, its hull configuration was not compatible with the camel fender because of the sharp hull curvature at the point of contact with the crane barge. The camel tended to swing beneath the side of the ship and was ineffective as a fender. The smaller contact area between the ship and the crane barge produced a high load on the small 3-foot diameter rubber fenders provided by the ship and made it difficult to maintain the rubber fenders in position and also caused fender failures.

5. Ship/Barge Mooring Lines

The mooring lines between the ship and crane barge were planned to be standard spring and breast lines together with bow and stern lines from the barge to the ship. The spring and breast lines installed on 21 March were 4-inch and 5-inch polyethylene and no bow/stern lines were used. No camel fenders were available on this date and only the ship's rubber fenders were used. This moor/fender arrangement proved inadequate for the existing sea conditions and resulted in damage to the ship. The tests were postponed until a re-configured moor/fender system could be obtained. On 22 March the mooring sizes were increased to 6-inch and 8-inch nylon and the camel log fender was installed in addition to the ship's rubber fenders. Bow and stern anchors from the crane barge were also used. Figure D.7 depicts the mooring lines used on 22-23 March. Because of the ship curvature at the stern, the camel log did not hold the crane barge away from the ship. Being under the ship's hull also restricted the crane rotation because the counterweights on the crane would contact the ship hull. No mooring line failures occurred between the ship and the crane barge on 22-23 March. However, the lack of an adequate fender system increased the possibility of more extensive ship damage and resulted in termination of the test on 23 March.

Top View LST



Note 1: All lines securing 6x15 to crane to be 5" nylon supplied by ACB-ONE.

Note 2: Camel secured by ships 6" nylon line between crane and ship.

Note 3: Spring lines between ship and crane to be 8" nylon line supplied by crane.

Figure D.7. Mooring lines.

E. ENVIRONMENT/RELATIVE MOTIONS

1. Environmental Data

During the open sea tests, 21-23 March, measurements or observations of various environmental factors were made and recorded. These were:

(1) surface currents near the LST (speed and direction)
(2) water waves near the LST (height, period and direction)
(3) wind
(4) weather elements
(5) waves near shore
(6) surf zone characteristics
(7) beach slopes
(8) beach soil properties

For those factors which vary from hour to hour, logs of the data are presented in Tables E.1 through E.6. The following paragraphs describe methods and summarize results.

<u>Surface Currents Near LST 1191</u>. The following diagram summarizes the surface current speed and direction (relative to the heading of LST 1191) for selected times during operations. The maximum speed observed during operations was 0.28 knot, as shown in the log, Table E.1.

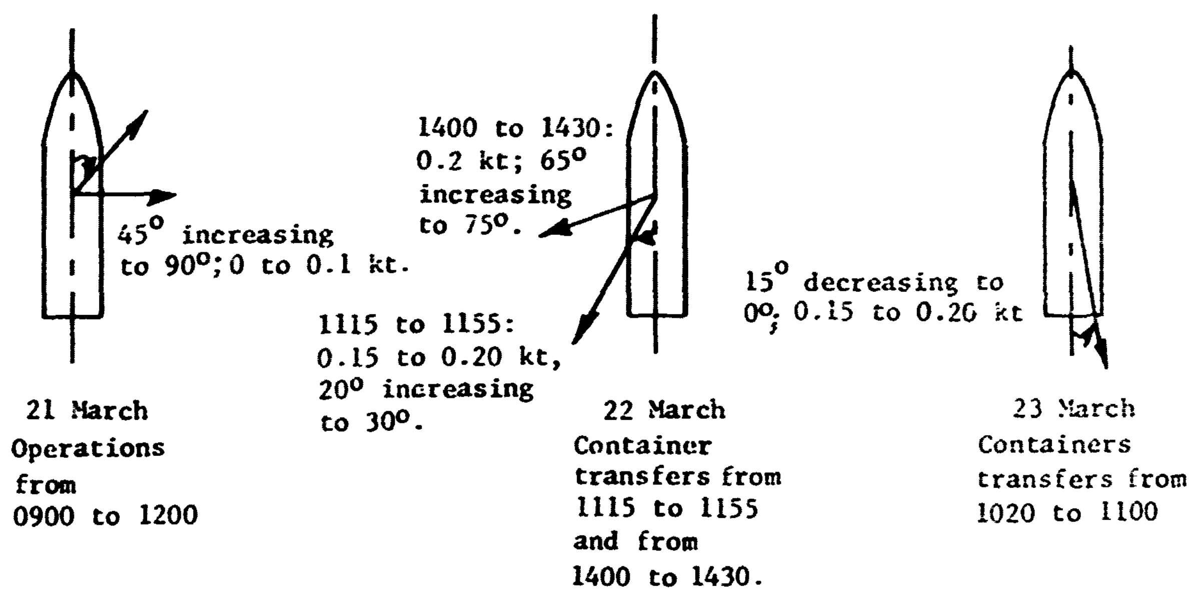


Table E.1. Surface Currents Near LST 1191

Day	Hour	Heading of LST 1191[b,d]	Surface Current[a]	
			Direction[b,c]	Speed[e]
21 March	0802	(246)	260	<0.05
	0940	(246)	305	<0.05
	1044	(246)	305	<0.05
	1149	(246)	340	0.10
22 March	0800	No datum	115	0.10
	0819	No datum	105	0.07
	0919	No datum	95	0.11
	1027	(257)	95	0.14
	1150	256	105	0.18
	1305	255	115	0.20
	1407	255	140	0.21
	1501	(256)	155	0.20
23 March	1023	255	60	0.15
	1125	(250)	75	0.20
	1232	No datum	95	0.15

Notes:

[a] Average values over the upper 10-15 ft layer.

[b] Current direction and LST heading are in degrees clockwise from true North.

[c] Current flows toward direction indicated.

[d] LST heading is toward direction indicated. Numbers in parentheses are estimated.

[e] Current speed is in knots.

Table E.2. Waves Near LST 1191

Day	By Strip Chart Examination				By Statistical Analysis					By Obs
	Time Interval (clock time)		Maximum Swell Height in Interval (ft)	Average Swell Period (sec)	Analysis Interval (clock time)		Wave Height		Period of Maximum Energy (sec)	Heading of LST 1191[a,b]
	From	To			From	To	Average of Highest Tenth (ft)	Average of Highest Third (ft)		
21 March	0800	1000	4	12	0900	0923	3.5	2.7	12	246
	1000	1200	5	12						246
					0845	0908	3.6	2.8	13	No datum
22 March	1115	1145	4	12	1115	1138	3.2	2.5	13	257 to 256
	1400	1430	4½	12	1400	1423	3.7	2.9	13	255 to 256
					1456	1519	3.7	2.9	12	No datum
23 March					0952	1015	4.8	3.8	8.5	256
	1000	1100	5½	9	1030	1053	5.0	3.9	8.5	255 to 250
					1242	1305	5.1	4.0	8.5	No datum

Notes: [a]Wave direction and LST heading are in degrees clockwise from true North.

[b]LST headings are from Table E.3.

2

Table E.2. Waves Near LST 1191

...l Analysis			By Observation from LST 1191			
Wave Height				Direction of Approach of Swells[a]		
...erage of Highest Tenth (ft)	Average of Highest Third (ft)	Period of Maximum Energy (sec)	Heading of LST 1191[a,b]	Dominant Swell (deg)	Other Swell (deg)	Event
3.5	2.7	12	246 246	264 264	None None	Abortive attempts to moor crane barge.
3.6	2.8	13	No datum	No datum	None	Barge motion test 2.
3.2	2.5	13	257 to 256	274	None	Transfer of containers from LST to ferry; barge motion test 3.
3.7	2.9	13	255 to 256	274	None	Transfer of containers from LST to ferry; barge motion test 4.
3.7	2.9	12	No datum	No datum	None	Barge motion test 5.
4.8	3.8	8.5	256	264	None	Barge motion test 6.
5.0	3.9	8.5	255 to 250	264	None	Transfer of containers from LST to ferry; barge motion test 7.
5.1	4.0	8.5	No datum	No datum	None	Barge motion test 8.

...t true North.

1

Table E.3. Wind Data[a]

Day	Hour	Data from LST 1191			Supplemental Wind Data			
		Heading of Ship[c,d]	Anemometer Readings		Anemometer on LCU 1618[b]		Anemometer on North	
			Direction[c,e]	Speed[f]	Direction[c,e]	Speed[f]	Direction[c,e]	Sp
21 March	0800				25	1	40	
	0840	246	251	5				
	0900				35	1	340	
	0930				315	1	0	
	1000				285	1	330	
	1100				325	3	310	
	1137	246	285	9				
	1200				345	4	300	
22 March	0800				315	8	330	
	0900				325	10	310	
	1000				315	10	310	
	1100				305	12	320	
	1112	257	324	12				
	1122	257	320	14				
	1130				305	13	300	
	1136	256	314	13				
	1149	256	316	13				
	1200				305	13	300	
	1224	255	314	14				
	1300				305	14	300	
	1400	255	320	16	305	16	310	
	1412	255	314	15				
	1421	256	314	16				
	1430	256	314	16	305	16		
	1500				295	16	300	
	1600				305	16	310	
23 March	0752	256	324	3				
	0800				105	1	30	
	0900				185	2	330	
	1000				135	6	250	
	1017	256	284	6				
	1032	255	288	9	185	7		
	1043	254	282	10				
	1056	250	280	11				
	1100				255	9	300	
	1200				275	13	290	
	1300				275	12	280	
	1400						270	

2

...ental Wind Data		
...s[b]	Anemometer on North Island	
...f	Direction[c,e]	Speed[f]
	40	3
	340	5
	0	0
	330	5
	310	6
	300	8
	330	8
	310	11
	310	10
	320	12
	300	12
	300	12
	300	13
	310	16
	300	16
	310	12
	30	5
	330	2
	250	9
	300	7
	290	12
	280	10
	270	10

Notes: [a]This table is also the primary log of LST headings.

[b]Anemometer 25 ft above water.

[c]Wind direction and LST heading are in degrees clockwise from true North.

[d]LST heading is toward direcation indicated.

[e]Wind blows from direction indicated.

[f]Wind speeds are in knots.

1

Table E.4. Miscellaneous Weather Data[a]

Day	Hour	Barometer (Station Pressure) (in. of Hg)	Temperature (°F)	Surface Visibility (stat. mi.)	Obstruction to Visibility	
21 March	0800	29.95	56	3	Haze	100% cover at
	0900	29.96	57	3	Haze	90% cover at 1
	1000	29.96	59	4	Haze	Clear
	1100	29.95	60	6	Haze	Clear
	1200	29.93	60	8	None	Clear
22 March	0800	29.99	58	7	None	100% cover at
	0900	30.00	59	7	None	100% cover at
	1000	30.00	60	7	None	90% cover at 2,
	1100	30.00	60	10	None	60% cover at 2,
	1200	29.99	60	10	None	30% cover at 2,
	1300	29.97	60	10	None	20% cover at 4,
	1400	29.95	60	10	None	70% cover of hi
	1500	29.94	59	10	None	60% cover of hi
	1600	29.93	59	10	None	30% cover of hi
23 March	0800	29.99	58	10	None	30% cover at 2,
	0900	29.99	59	10	None	Clear
	1000	30.00	60	10	None	Clear
	1100	29.98	62	10	None	Clear
	1200	29.95	61	10	None	20% cover of hi
	1300	29.93	62	10	None	20% cover of hi

Notes: [a]See Table E.3 for wind data. There was no precipitation during the tests.

2

aneous Weather Data[a]

Obstruction to Visibility	Sky
Haze	100% cover at 1,100 ft
Haze	90% cover at 1,500 ft
Haze	Clear
Haze	Clear
None	Clear
None	100% cover at 2,000 ft
None	100% cover at 2,300 ft
None	90% cover at 2,300 ft
None	60% cover at 2,500 ft
None	30% cover at 2,500 and 20,000 ft
None	20% cover at 4,000 ft, 50% cover at 20,000 ft
None	70% cover of high clouds
None	60% cover of high clouds
None	30% cover of high clouds
None	30% cover at 2,500 ft
None	Clear
None	Clear
None	Clear
None	20% cover of high clouds
None	20% cover of high clouds

tation during the tests.

Table E.5. Waves near Shore[a]

Day	Measurement Interval (clock time)		Measured Values 1,000 ft Offshore[b]			Estimated (Comput for Break	
	From	To	Maximum Height Observed (ft)	Significant Height[c] (ft)	Period of Dominant Waves (sec)	Most Probable Value of Maximum Height[d] (ft)	Signif Heig (ft
22 March	0900	0921	7.0	5.0	13.0	11.9	7.
	1100	1120	6.8	4.3	12.3	10.5	6.
	1225	1250	5.8	3.9	11.7	10.2	6.
	1452	1512	5.8	4.4	11.7	10.9	7.
23 March	0900	0920	9.9	5.7	8.7	12.5	8.
	1100	1120	9.5[e]	4.8	9.0	11.2	7.
	1300	1319	7.2	4.8	9.0	11.1	7.

Notes: [a]See Table E.6 for other surf zone characteristics

[b]Depth of water 1,000 ft offshore was 20 ft at MLLW.

[c]Significant height is average height of the highest third of the waves.

[d]This is a computed most-probable value for the height of the highest wave occurring interval of the length shown (20 to 25 minutes) when the significant height is as sh M. S. Longuet-Higgins, "On the statistical distribution of the heights of sea waves, of Marine Research, Vol. II, No. 3 (1952), pp. 245-266.

[e]The probability that this value might have been exceeded is 5%, according to Longuet theory.

2

ble E.5. Waves near Shore[a]

hore[b] od of nant es c)	Estimated (Computed) Values for Breakers: Most Probable Value of Maximum Height[d] (ft)	Significant Height[c] (ft)	Dominant Period (sec)	Event
.0	11.9	7.9	13	
.3	10.5	6.9	12	
.7	10.2	6.6	12	Beaching and unloading of first ferry, 1225 to 1247.
.7	10.9	7.2	12	Beaching and unloading of second ferry, 1445 to 1505.
7	12.5	8.0	9	
0	11.2	7.2	9	Ferry-causeway marriage trails, 1129 to 1300.
0	11.1	7.1	9	

ird of the waves.

of the highest wave occurring in a time
he significant height is as shown. See
n of the heights of sea waves," Journal
.

ed is 5%, according to Longuet-Higgins'

Table E.6. Surf Zone Characteristics[a]

Day	Hour	Breaker Type		Breaker Angle with Shoreline (deg)	Surf Zone Width (ft)	Number of Lines of Breakers	Litoral Current	
		Fraction Plunging (%)	Fraction Spilling (%)				Speed (knots)	Direction[b]
21 Mar	0600	90	10	0	250	2 to 3	0.3	L
	0800	90	10	0	300	3 to 4	0.3	L
	1000	70	30	0	250	2 to 3	0.3	L
	1200	30	70	0	250	2 to 3	0.4	L
22 Mar	0600	80	20	0	250	2 to 3	0.3	L
	0800	60	40	0	250	2 to 3	0.3	L
	1000	50	50	0	250	2 to 3	0.3	L
	1200	20	80	0	250	2 to 3	0.3	R
	1400	30	70	0	250	2 to 3	0.3	R
23 Mar	0600	80	20	0	300	3 to 4	0.4	R
	0800	40	60	0	230	3 to 4	0.1	R
	1000	15	85	0	275	3 to 4	0.1	R
	1200	10	90	0	275	3 to 4	0.1	R

Notes: [a]See Table E.5 for breaker heights and periods.

[b]L indicates the direction is toward the left of an observer facing landward. R indicates toward the right.

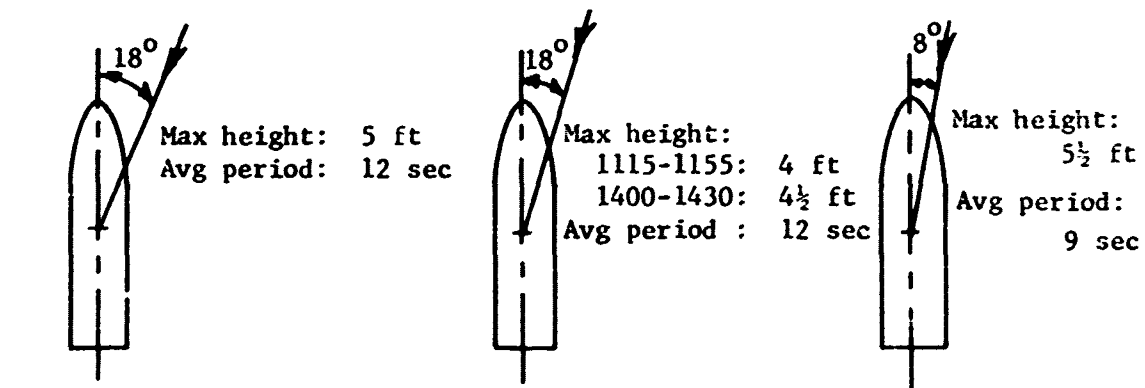
As a base for current measurements, an LCU (1618) was three-point moored bow-on to the predominant swells at a point about 800 yards west of LST 1191, near the centerline of boat lane 5 (see Figure 4). A profiling current meter (Marine Advisers Q15) was operated over the side by means of a portable winch and a short boom. This meter provides deck read-out and in-situ strip-chart recording. Correlation with the tide was facilitated by means of a wave and tide gage (Hydro Products 521), placed on the bottom about half way between LCU 1618 and LST 1191. The depth of water was about 52 feet. This instrument was placed from a LARC V. The latter was also used for making spot measurements of current at other points around the LCU to investigate area variability.

The LCU proved to very satisfactory as a measurements platform. A three-point mooring is mandatory. A smaller craft would be undesirable in rough water. It is recommended that two, three-point moored, LCUs be used at OSDOC II, Fort Story, where greater variability in the current is expected.

The LARC V was satisfactory as a workboat. While other small boats could be used, an advantage of the LARC V was that it permitted transporting of people and supplies to and from the beach. However, with no fendering of any kind, the LARC V could not be brought alongside the LCU in rough water without some damage.

The measuring equipment was furnished and operated by personnel of the Coastal Studies Institute, Louisiana State University, Baton Rouge. Financial support was provided entirely by Geography Programs, Office of Naval Research.

<u>Waves near LST 1191</u>. The dominant waves during the tests were swells of length about 450 ft (on 21 and 22 March) and 300 ft (23 March). The following diagram summarizes the height, period, and direction of the swell for selected times. Fuller documentation is given in Table E.2.



21 March
Operations from 0900 to 1200

22 March
Container transfers from 1115 to 1155 and from 1400 to 1430

23 March
Container transfers from 1020 to 1100

The height and period data were obtained from measurements with a wave-riding buoy (Datawell-Laboratory Waverider). The buoy was placed in the water from LCU 1618, after the vessel was anchored, and was tethered to the crown of the bow anchor by means of a light mooring line about 150 ft long. The buoy is a steel sphere, about 28 inches in diameter, containing an accelerometer, integrating circuits, telemetry equipment, and batteries. The buoy-displacement signal was telemetered about 3,000 yards to the beach, where it was recorded on both paper strip chart and magnetic tape. The strip-chart record provided directly an estimate of the maximum height and average period of the swells (see Table E.2). Segments of the magnetic-tape record were analyzed statistically to obtain such measures as the significant wave height (average height of the highest third of the waves), as shown in Table E.2. This analysis also yielded the graphs of power spectral density, Figures E.1 through E.8. These graphs show that in some instances there was little wave energy in the sea except for the dominant swell (for example, Figures E.1 and E.2, which pertain to periods of light wind in the forenoon, show hardly more than a "spike" at the frequency of the swell), while in other instances (for example, Figure E.5) significant energy at higher frequencies has begun to develop under the influence of local winds.

The wave spectra of Figures E.1 through E.8 are useful as input for calculations of wave-induced motions of a vessel. Significant energy in the sea was generally confined to a narrow range of direction. Usually the swell was totally dominant and the developing shorter waves traveled in roughly the same direction as the swell, as indicated by the wind data. Therefore, the sea was practically "one-dimensional," so that representation by a one-dimensional power density spectrum is meaningful.

The swell direction data were obtained by observations from aboard LST 1191 by an experienced Navy aerographer attached to COMPHIBOPSSUPPAC. These observations were the only source of data on wave direction.

The Datawell system was furnished by the Pacific Missile Range Directorate, Range Operations Department, Oceanographic and Geodetic Branch, Point Mugu, California, and was operated by NCEL personnel. This system operated flawlessly. It is recommended for further use in conjunction with measurements of wave direction. For a sea with a narrow directional spread of wave energy, it appears that visual observations and aerial photographs are adequate to define the wave direction relative to the ship. Otherwise, more elaborate techniques are necessary, particularly if the relationships between waves and vessel motions induced by waves are to be studied.

Wind. Typically, the wind speed rose during the morning, reaching a maximum shortly after noon. Unless the wind was light, the direction was practically constant during each series of operations. The wind data are summarized in rough fashion in the following diagram Fuller documentation appears in Table E.3.

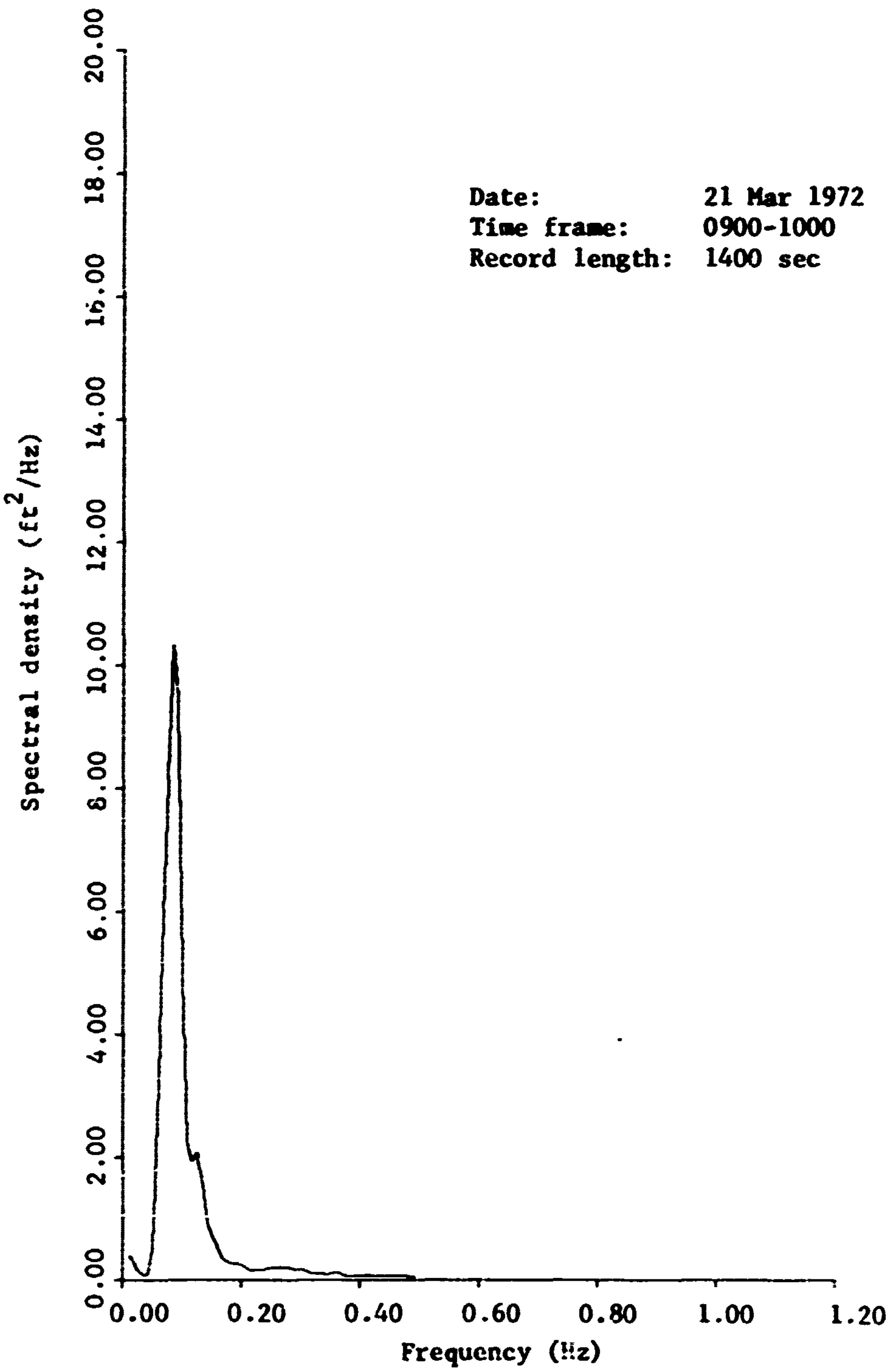


Figure E.1. Power spectral density, wave data set no. 1

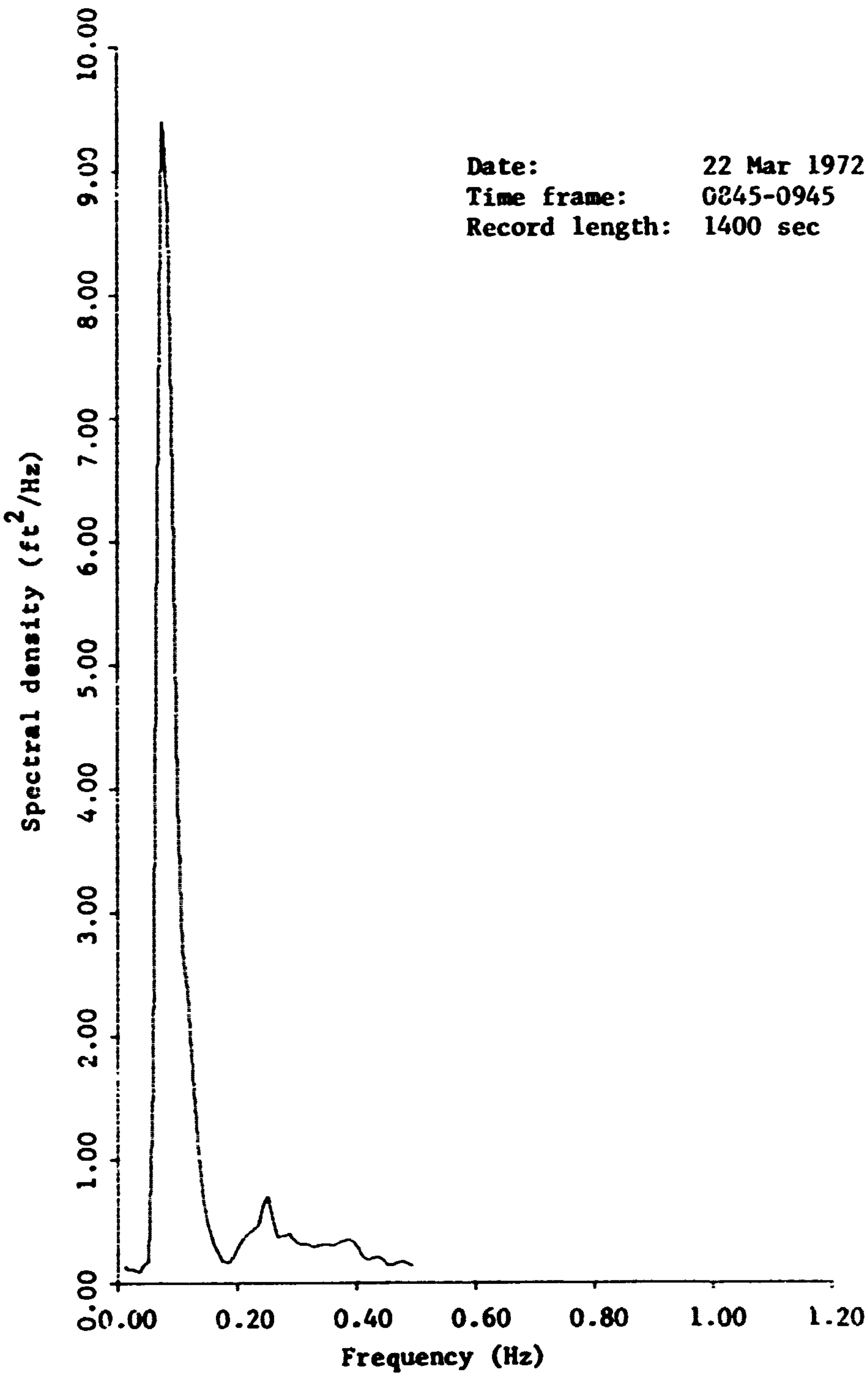


Figure E.2. Power spectral density, wave data set no. 2

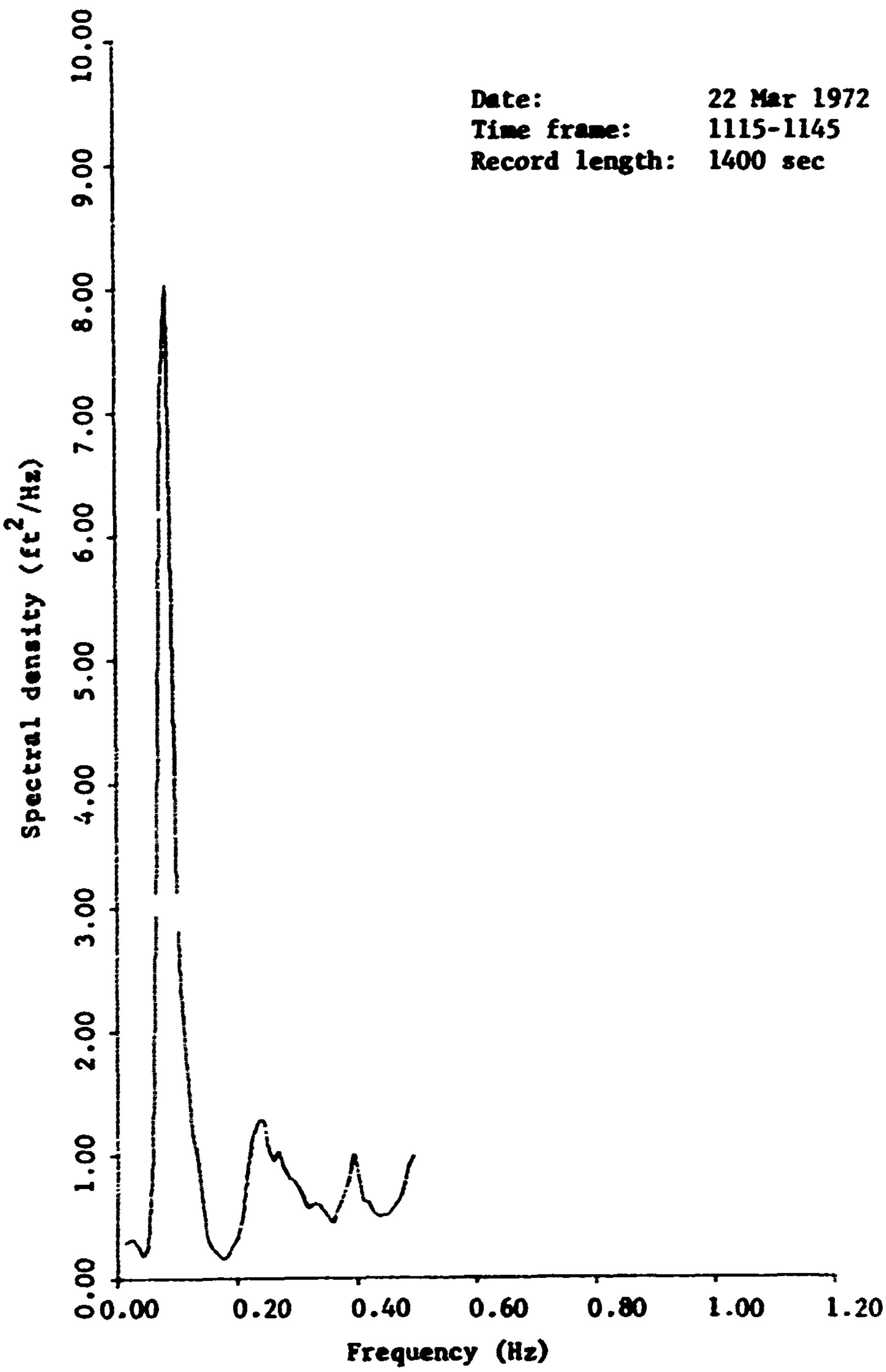


Figure E.3. Power spectral density, wave data set no. 3

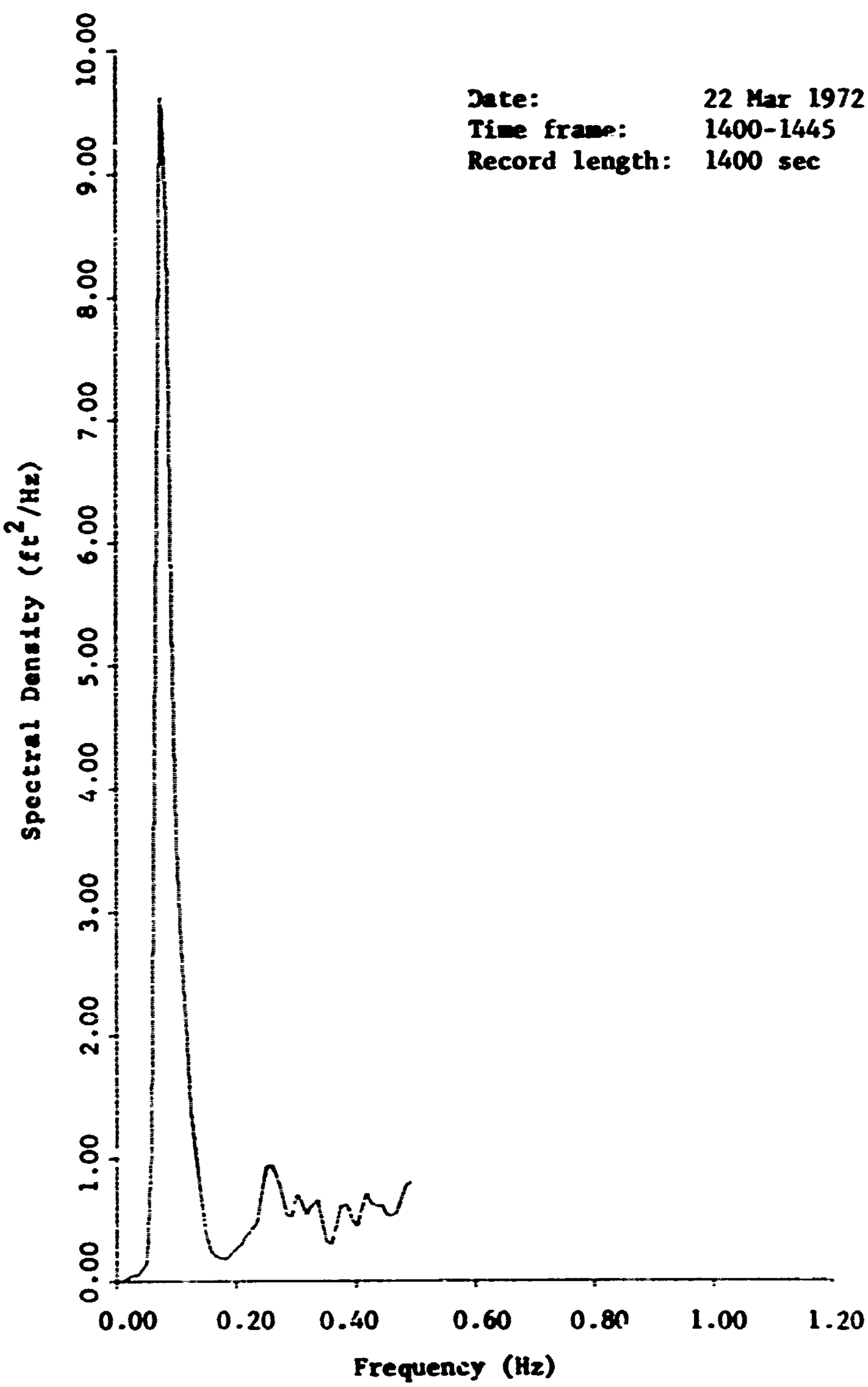


Figure E.4. Power spectral density, wave data set no. 4

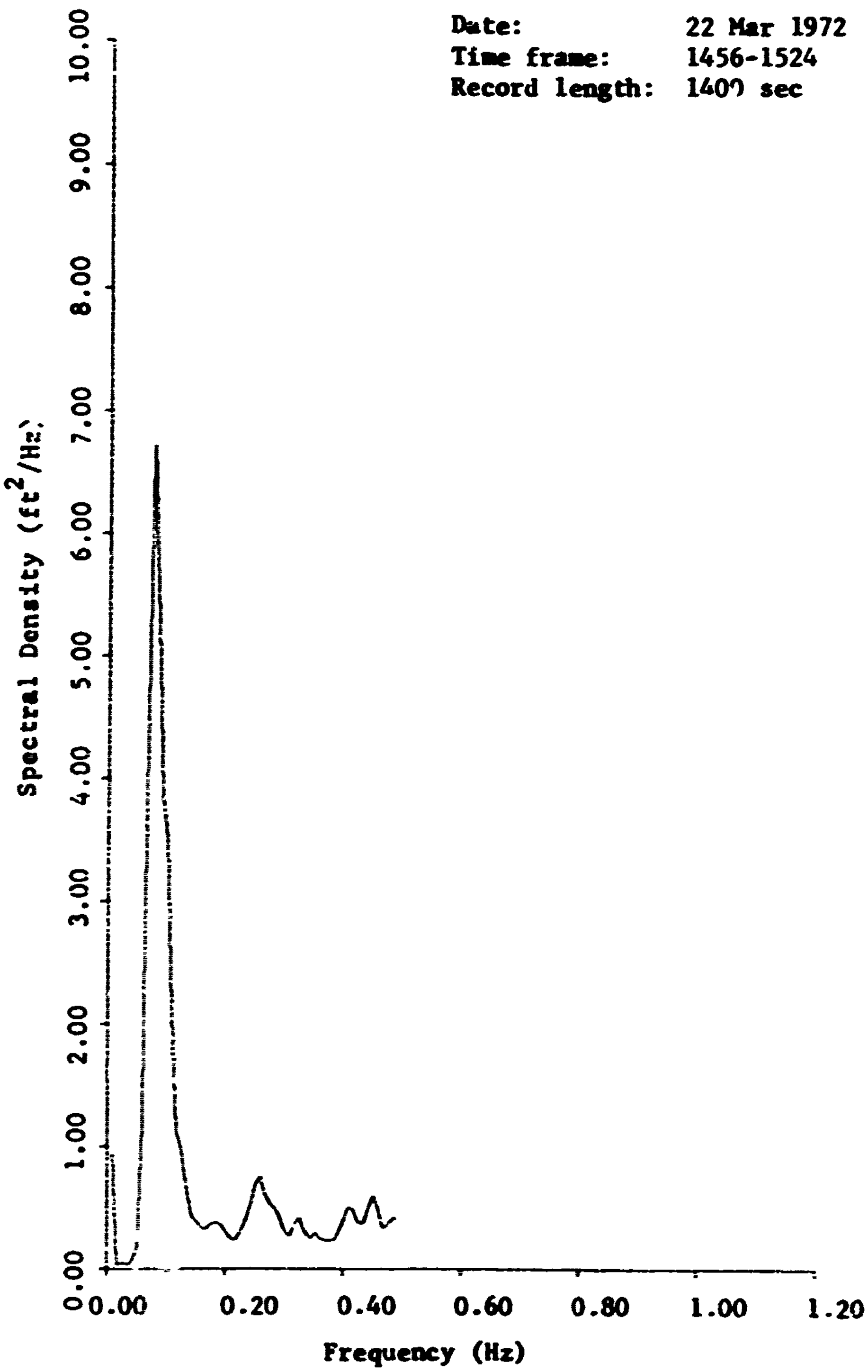


Figure E.5. Power spectral density, wave data set no. 5

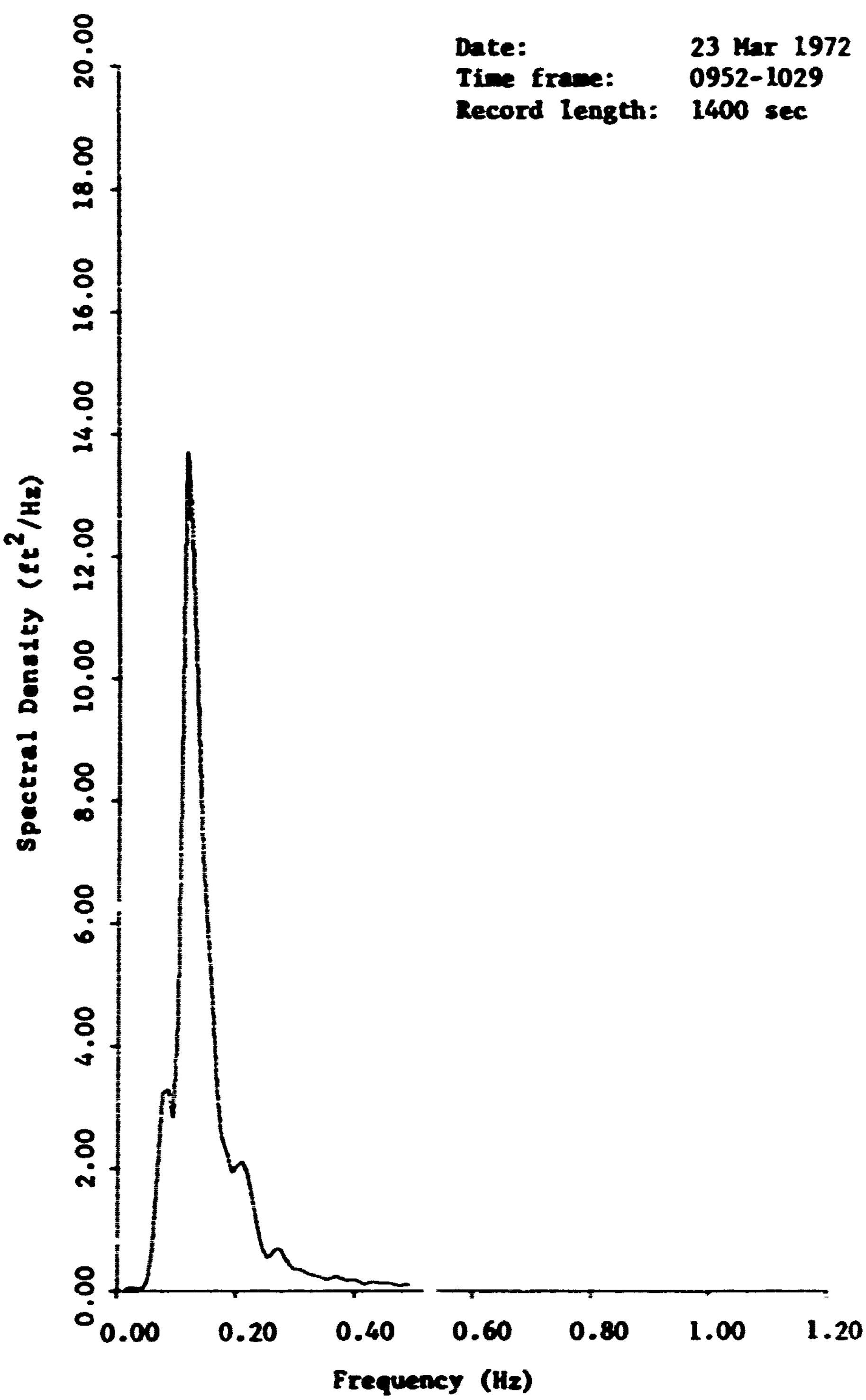


Figure E.6. Power spectral density, wave data no. 6

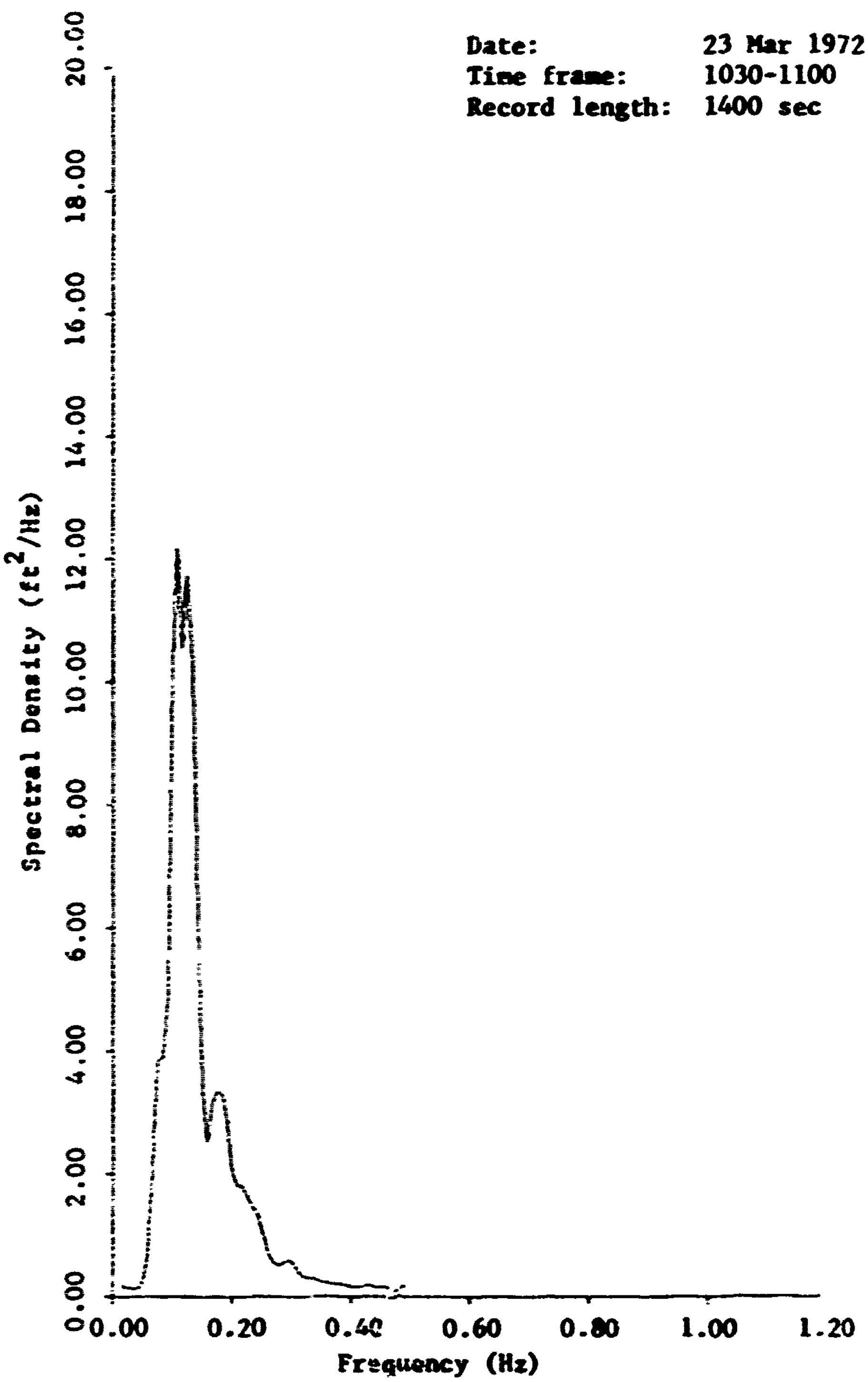


Figure E.7. Power spectral density, wave data set no. 7

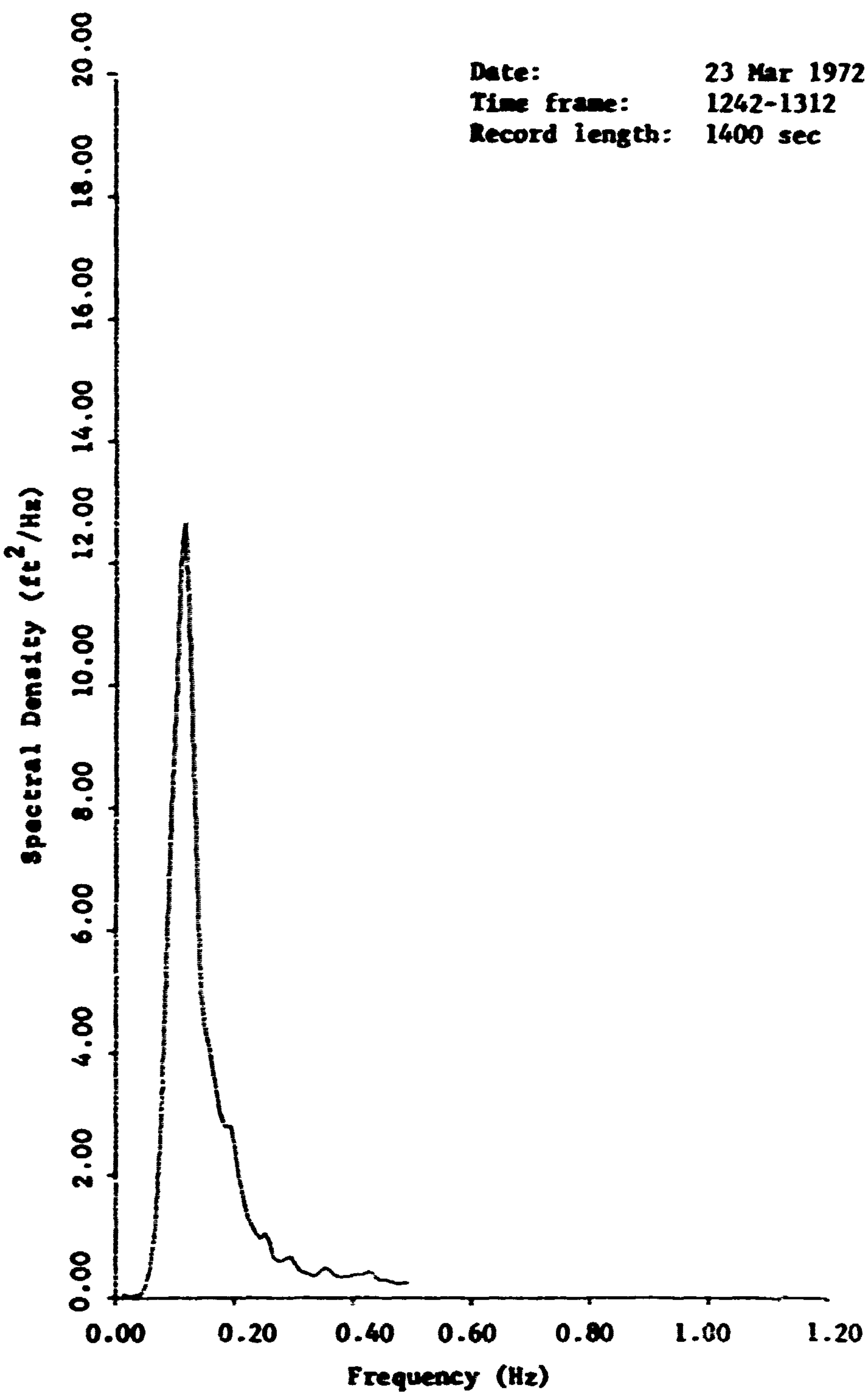
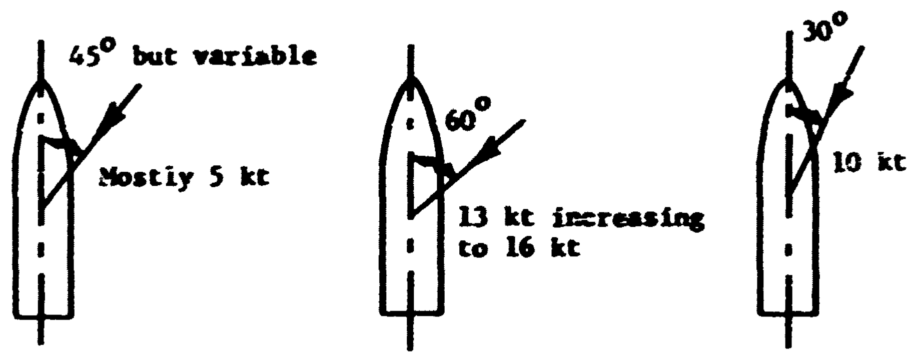


Figure E.8. Power spectral density, wave data set no. 8



21 March
Operations from
0900 to 1200

22 March
Container transfers
1115 to 1155 and 1400
to 1430

23 March
Container transfers
1020 to 1100

Wind data were obtained with the anemometer on the LST 1191 by the aerographer aboard. Supplemental data were obtained from a portable recording anemometer mounted on LCU 1618 and also from the records of the Fleet Weather Facility, North Island, San Diego, located about 9,000 yards away.

<u>Other Weather Elements</u>. Weather data in addition to wind were obtained from the records of the Fleet Weather Facility, North Island. Table E.4 summarizes these data.

<u>Waves Near Shore</u>. Wave heights and periods at a point outside the surf zone (about 1,000 feet offshore) were obtained directly by measurement. From the measured values, the heights of the dominant breaking waves were estimated by means of an empirical formula involving the measured heights and periods and the bottom slope.*

Table E.5 summarizes these data. A rough summary for selected times is as follows:

Day	Event	Wave Environment
22 March	Beaching of ferries	Significant breaker height, 7 feet. Dominant period, 12 seconds.
23 March	Ferry-causeway marriage	Significant wave height, 5 feet. Maximum observed wave height, 9.5 feet. Dominant period, 9 seconds

*See B. Le Méhauté and R. C. Y. Koh, "On the breaking of waves arriving at an angle to the shore," Journal of Hydraulic Research, Vol. 5, No.1 (1967), pp. 67-88.

The measurements were made with a pressure sensor (Marine Advisers A2b) placed on the bottom in about 20-foot water depth (MLLW). Cable was laid from the pressure transducer to a strip-chart recorder on the beach. A LARC V was used to install the pressure head and lay the cable. Figure E.9 shows the installation. The gage was about 100 yards seaward of the end of the eight-section causeway.

The pressure gage and cable can be readily installed with a LARC V. For measurements outside the surf zone where the bottom is fairly regular, the method is excellent. For determining breaker heights, the method is fair to good if there is no shoal between the gage and the breaker zone. However, direct measurement of breakers is preferred if there is a significant shoal.

Personnel of the Marine Corps Development and Education Command, Assault Amphibian Test Branch, Camp Pendleton, California, furnished the instrumentation, installed the system, and operated the recorder.

<u>Surf Zone Characteristics</u>. Standard surf observations were made by personnel of BMU-ONE, Naval Amphibious Base, Coronado, California. Table E.6 summarizes these observations.

During the beachings of the loaded ferries, the breakers were observed to be about 30% plunging and 70% spilling. The breakers were parallel to the shoreline.

<u>Beach Slopes</u>. Profiles of the beach near the beaching point and near the eight-section causeway were obtained by NCEL personnel with a level and rod. These profiles are shown in Figure E.10.

The slope of the beach where the trucks rolled off the first ferry (at about 1230 hours, 22 March) was about 7%. The slope where the trucks rolled off the second ferry (at about 1500 hours, 22 March) was about 10%. The steepest slope traversed by the trucks was about 30%.

<u>Beach Soil Properities</u>. Soil samples were obtained by NCEL personnel at points 5 feet and 45 feet west (seaward) of the edge of the On-Fast hardstand pad; particle size analyses (ASTM D 422-63) and soils classifications (ASTM D 2487-69) were performed. In addition, field (in-place) determinations of moisture content and density (ASTM D 2922-71) were made. The results are shown in Figues E.11 and E.12 (sieve analyses) and in the following:

Test Location	Unified Soils Classification	In Place Density (pcf)	Moisture Content (%)
5 ft west of pad	SP	99.6	1.8
45 ft west of pad	SP	98.9	2.5

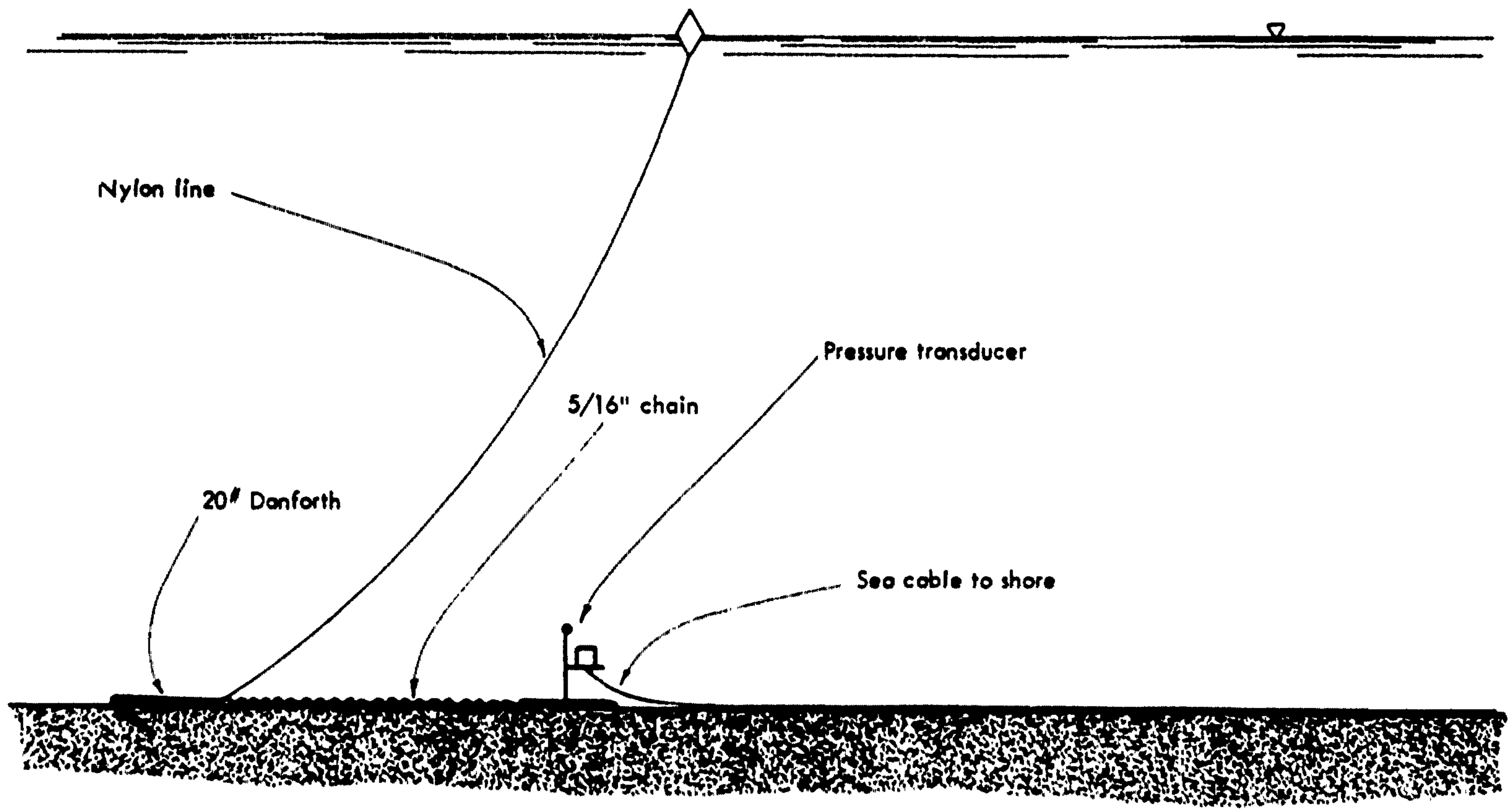


Figure E.9. Nearshore wave gage.

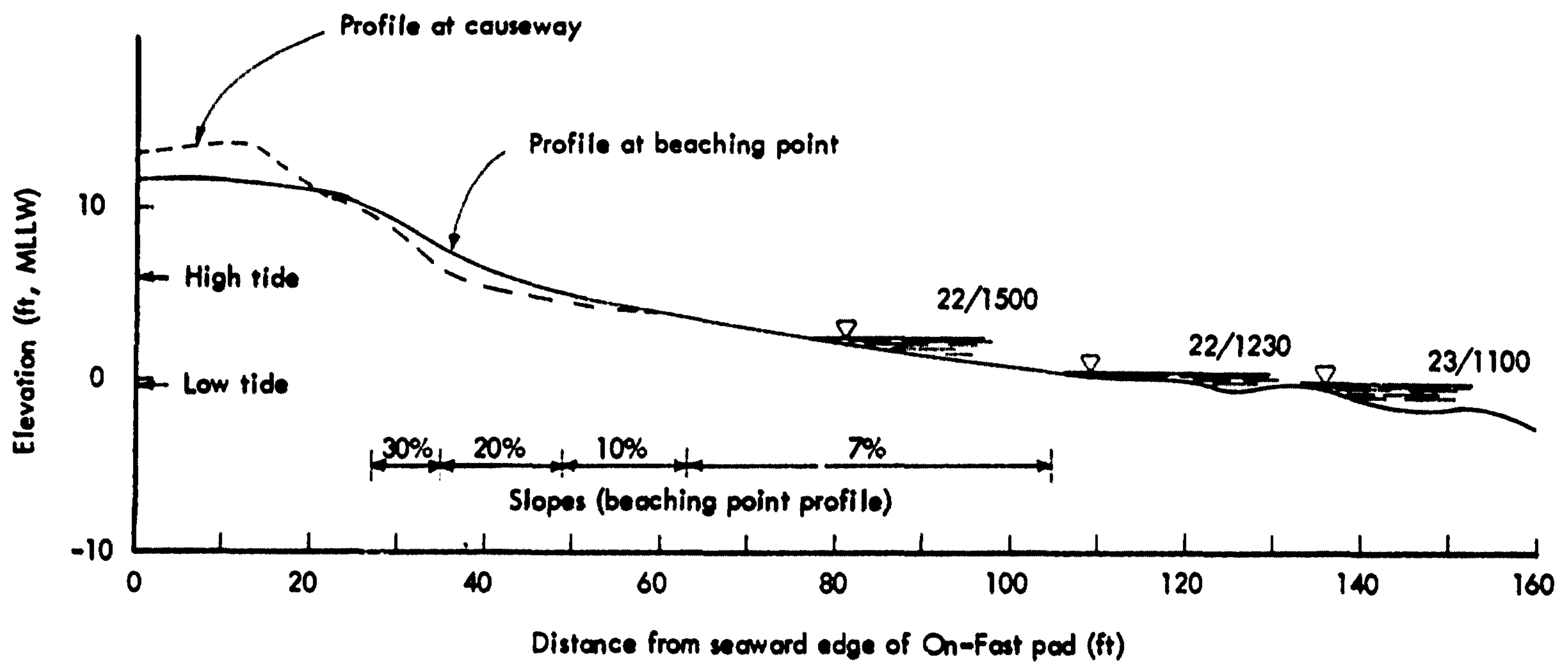


Figure E.10. Beach profiles.

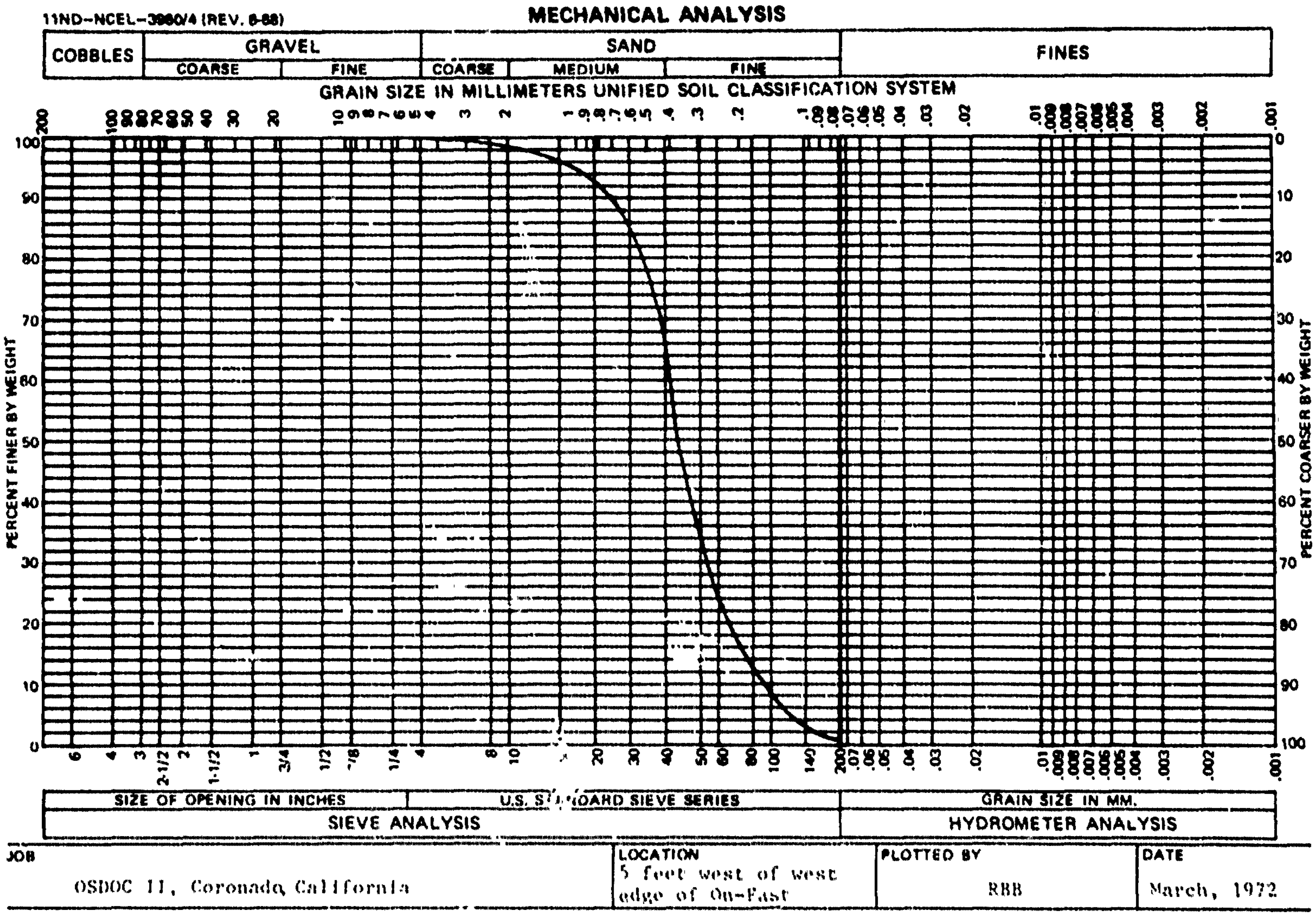


Figure E.11. Sieve analysis.

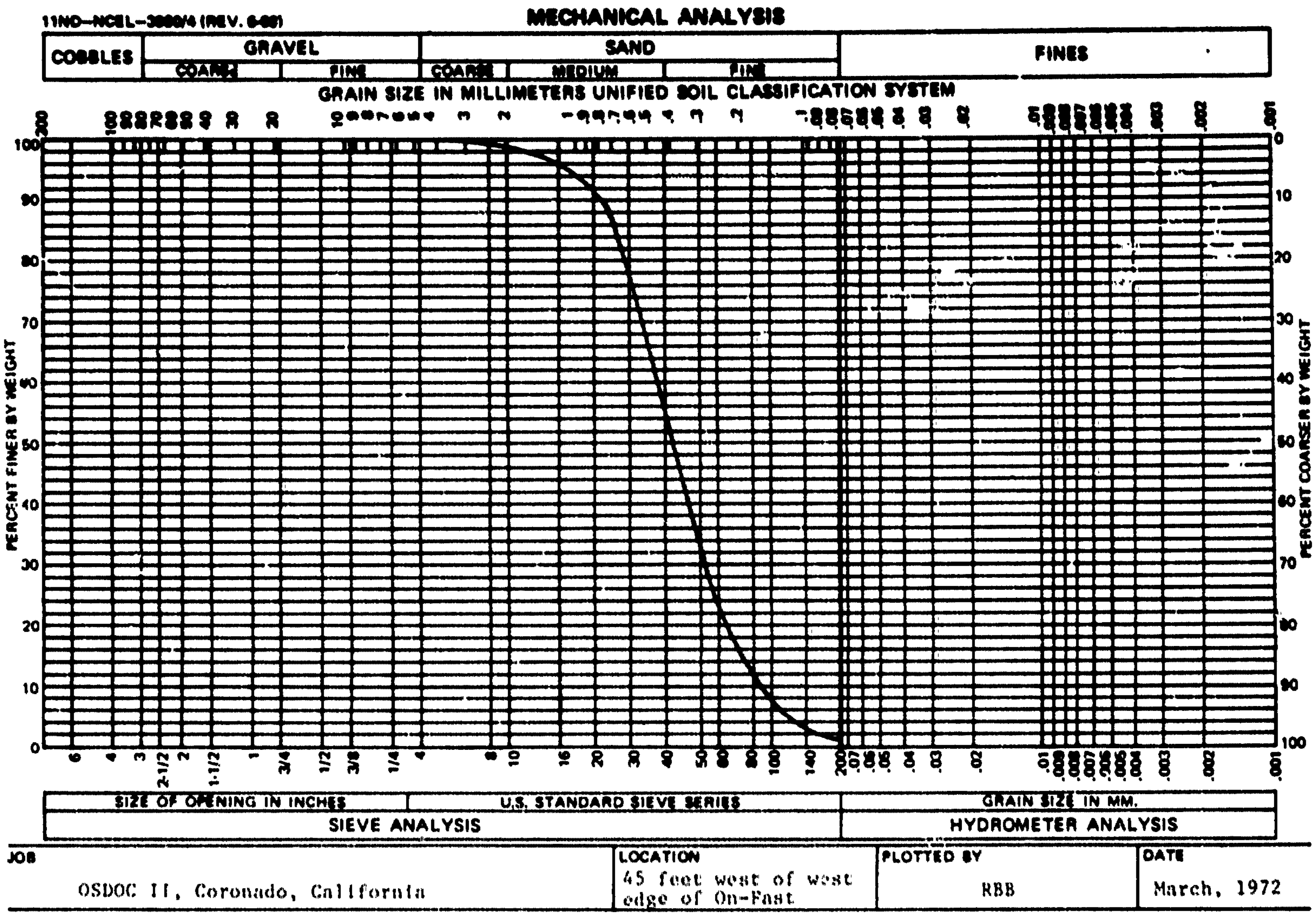


Figure E.12. Sieve analysis.

Measurements were also made by NCEL personnel with a standard Army penetrometer (cone angle 30°, diameter at base of cone 2.03 cm, shaft diameter 1.59 cm, shaft length 18 inches). Measurements were made at the top of the berm near the edge of the On-Fast pad and near the shoreline when the tide elevation was 2.8 ft and falling. Two readings were made at each location. The penetrometer readings (psi, maximum) were as follows:

Location	Interval (in)	Penetrometer Readings (psi) First Reading	Second Reading	Average
Edge of On-Fast	0 to 3	75	80	78
	3 to 6	160	200	180
Shoreline	0 to 3	35	50	42
	3 to 6	140	170	155

2. Barge and Ship Motion

The roll, pitch, heave and surge of the crane barge and the vertical acceleration at a station aboard the LST were measured by a portable ship motion data acquistion system developed at the Naval Ship Research and Development Center. The data acquisition system is compactly housed in two suitcase sized aluminum cases (Figure E.13). Auxiliary gear such as cable, portable voice recorder, a C-clamp mounted accelerometer and a small battery powered oscilloscope are carried in three smaller cases.

The data acquisition system obtains data on roll and pitch angle, local heave acceleration and the acceleration at a remote station. A vertical gyroscope measures angular displacement about the roll and pitch axes. True heave acceleration is measured by an accelerometer mounted on the internal stable platform of the gyroscope. A second accelerometer, mounted on a C-clamp and connected by cable to the recorder, can be placed at any point of interest. Mounted upright it will measure vertical acceleration; whereas, if it is rotated 90°, transverse or longitudinal accelerations in the horizontal plane can be measured. Depending on the choice of sensitivity, both high g impact and low g slowly varying accelerations can be measured with this accelerometer. All data is recorded on a portable four channel FM cassette tape recorder. Power for the system is supplied by recharageable 24-V batteries built into the tape recorder package, or it can be provided by any easily available source, e. g., two 12-V automotive batteries wired in series.

Tests. Barge motion data were obtained during the three days of testing at sea. The instrumentation packages containing the stabilized gyroscope and recorder were placed atop a deck house at a station 63.2

feet forward of the stern of the crane. This location was chosen since it was near the CG of the barge, accessible and out of the way of personnel working aboard the barge. The remote accelerometer was mounted to a grill, one foot above the main deck, of the LST at a location 22 feet from the stern. A 200-foot long electrical cable, tied off to cleats aboard the LST and the crane barge with sufficient slack between tie points, connected this accelerometer to the signal conditioning and tape recorder packages atop the crane deck house. For the last test on 22 March and throughout the last day of testing, the remote accelerometer was attached to the crane deck house at a location immediately below the data acquisition system and was positioned to measure the surge acceleration of the barge.

<u>Results and Discussions</u>. The instrumentation worked well during the three days of testing at sea. A total of nine data runs were made, seven of which were later analyzed. These seven tests are summarized in Table E.7. The second column in this table indicates which wave data set (wave data are presented and discussed elsewhere in this report) corresponds in time to the vessel motion tests listed in column 1. The date and time of each test and the angle of approach of incident swell with respect to the stern of the barge are found in columns 3 and 4 (respectively).

Table E.7. Summary of Barge/LST Motion Tests

Vessel Motion Test	Corresponding Wave Data Set*	Date/Time	Angle of Wave Incidence**
1	1	3-21/0946-1045	25°
2	2	3-22/0845-0931	25°
3	3	3-22/1114-1156	25°
4	5	3-22/1454-1524	25°
5	6	3-23/0951-1029	15°
6	7	3-23/1031-1102	16°
7	8	3-23/1242-1312	180°

*See Figures E.1 through E.8.

**Barge stern - port side

Each analog record of barge and LST motion was digitized, and the resulting time series data analyzed to produce a graph of the spectral density function.* Four of these graphs, from motion test number 4, are

*All motion data analysis was performed by personnel of the Naval Ship Research and Development Center at Bethesda, Maryland.

shown in Figures E.14 through E.17. Each of the curves is sharply peaked at a frequency of about 0.47 rad/sec (13.3 second period) which is close to the frequency of the peak in the wave spectrum (Figure E.5 for Wave Data Set No. 5). The secondary peaks in Figure E.16 for the roll spectrum are less obviously explained. The barge crane does, however, have a natural roll period around five seconds, and the wave spectrum exhibits appreciable energy density between two and five seconds (which reflects the presence of locally wind generated waves), and this coincidence could conceivably explain the higher frequency coupling noted in the roll spectrum.

Table E.8 summarizes the results of the spectral analysis of the barge and LST motion data. For each motion the significant heave, surge, roll and pitch of the barge and the significant vertical displacement of the station aboard the LST are presented. Generally, the results vary little from test-to-test which is reflective of the comparatively constant swell conditions encountered during the Coronado tests. However, the average swell period did decrease somewhat on the third day, and this fact is reflected in the larger values recorded for barge pitch and roll.

One of the objectives of obtaining wave and motion data at Coronado was to compare this data with analytical predictions made with a relative ship motion mathematical model.* The model, which is based on strip theory and which considers neither interaction between ships nor the shallow water effects on ship added-mass and damping, was used to generate estimates of the response amplitude operators (RAO's) for the absolute motion of both the barge crane and the LST. Table E.9 contains an abbreviated listing of vessel specifications inputed into the analytical model.

Table E.8. Significant Barge and LST Motion Double Amplitudes*

Vessel Motion Test	Barge Heave (ft)	Barge Surge (ft)	Barge Roll (deg)	Barge Pitch (deg)	LST Vertical Displacement (ft)
1	1.79	----	0.60	1.11	1.98
2	1.83	----	0.80	1.06	1.98
3	1.57	----	0.66	1.05	1.90
4	1.76	3.57	0.62	0.97	----
5	1.87	3.37	0.93	1.43	----
6	2.00	3.58	1.18	1.46	----
7	2.24	1.07	1.37	----	----

*Computed from power density spectra.

*D. A. Davis and H. S. Zwibel, NCEL Technical Note N-1183: "The relative motion between ships in random head seas," Port Hueneme, California, Sep 1971.

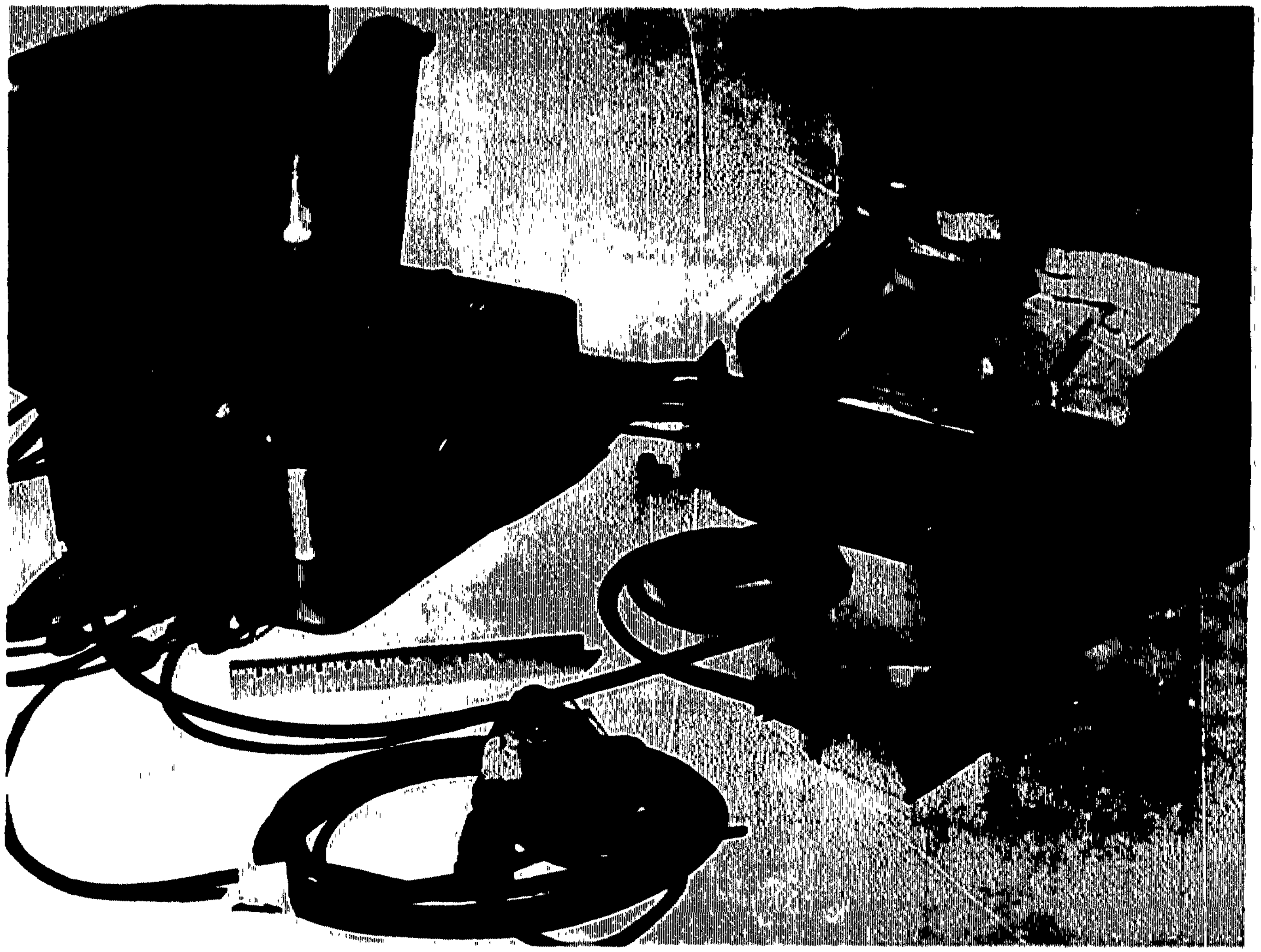


Figure E.13. NSRDC ship motion data acquisition system.

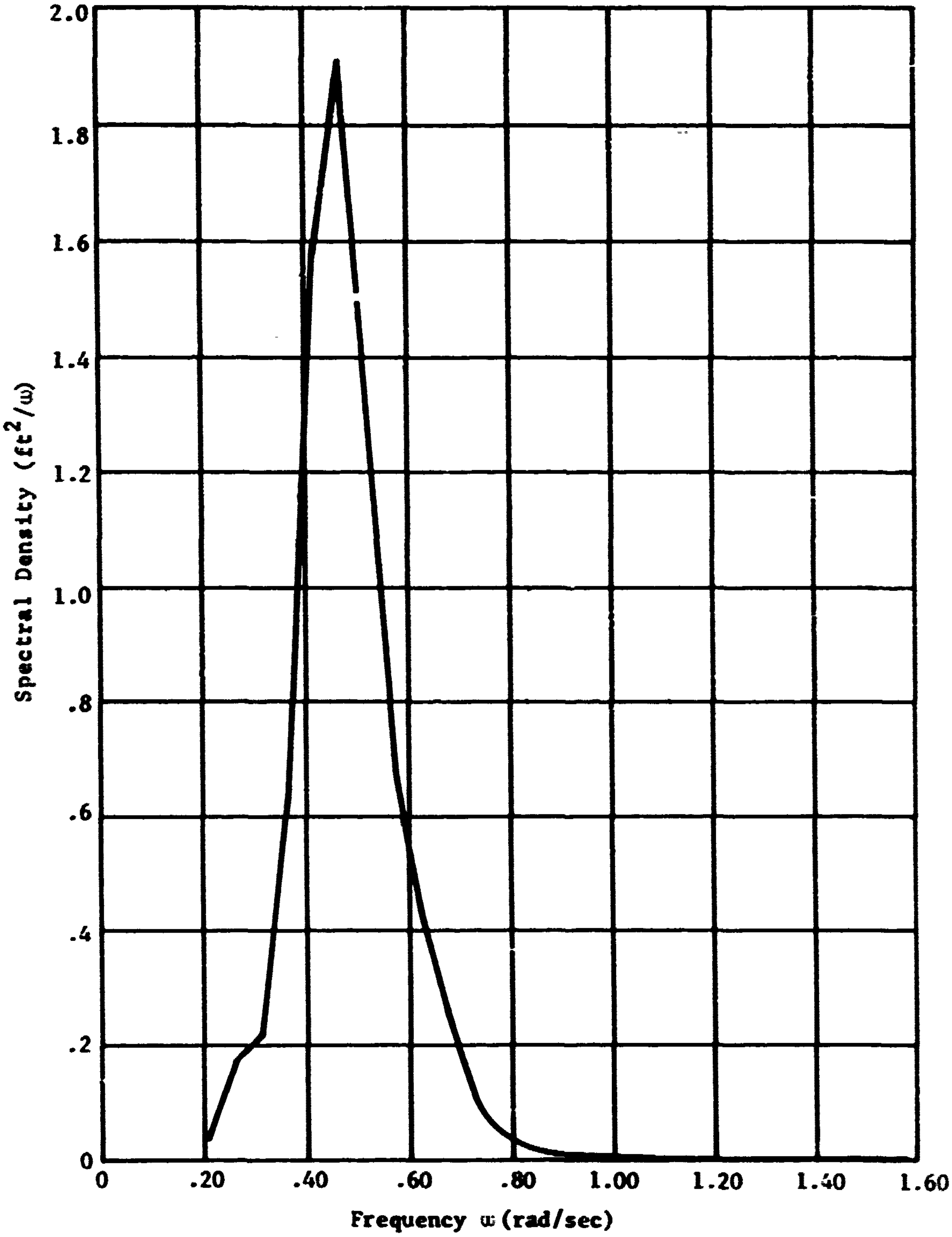


Figure E.14. Typical barge heave spectrum (Test 4).

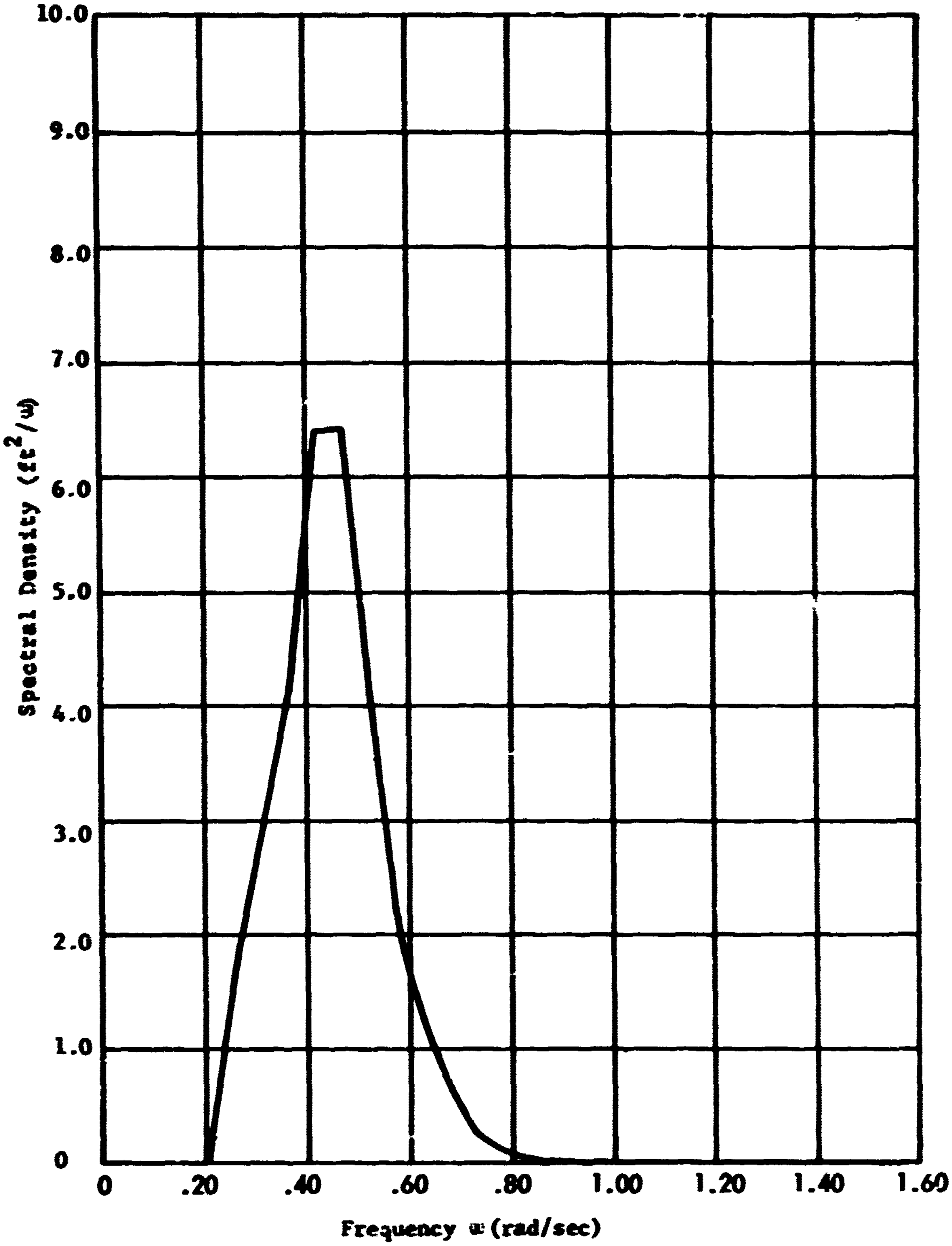


Figure E.15. Typical barge surge spectrum (Test 4).

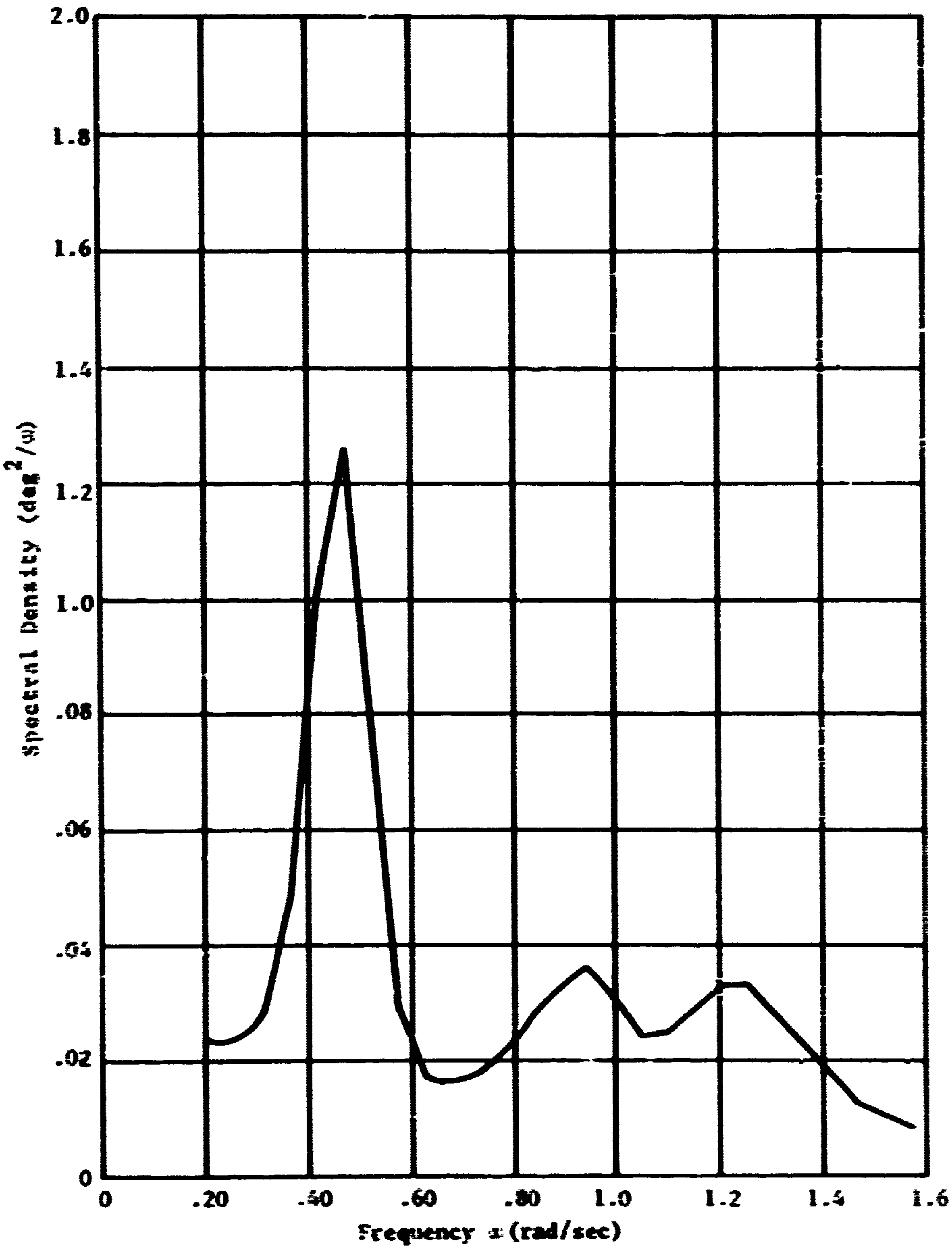


Figure E.16. Typical barge roll spectrum (Test 4).

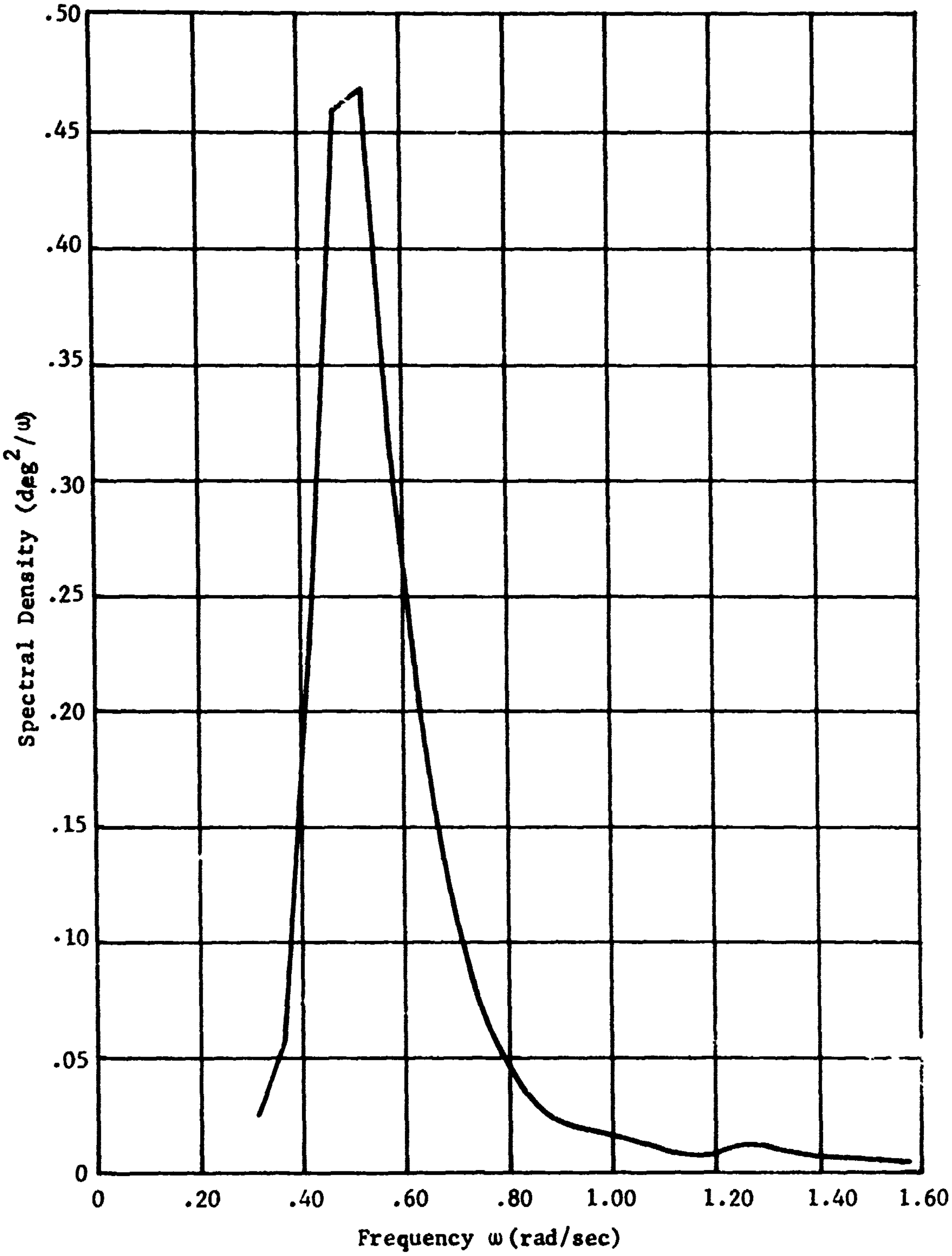


Figure E.17. Typical barge pitch spectrum (test 4).

Table E.9. Vessel Specifications Used in Analysis

Vessel	Length Overall (ft)	Beam (ft)	Mean Draft (ft)	Displacement (LT)
YD-193	140.0	70.0	5.6	1550
LST	522.0	69.2	11.6	5880

The predicted RAO's appear as solid curves in Figures E.18 through E.33. The vertical dotted lines drawn at 0.42 and 0.90 rad/sec delineate the frequency band within which appreciable energy exists in the measured motion and wave spectra. The experimental response amplitude operators plotted as points in Figures E.18 through E.33 were determined in the usual manner, that is, by taking the square root of the quotient of the motion spectral ordinate and wave spectral ordinate at identical values of frequency, ω.

Considering the ideal* wave conditions prevailing throughout the tests, enough discrepancy exists between the experimental results and those predicted by the model that some comment is warranted. It should be noted, for example, that the ship motion data acquisition system was originally designed to measure high g accelerations and angular deflections expected aboard landing craft and other small vessels. Its use aboard the much larger crane barge and LST resulted in recording of data levels approaching the limits of system sensitivity. Assuming, however, no appreciable data distortion due to low signal level, other explanations can be tendered to explain differences in theory and experiment, to wit:

a. The barge pitch and heave experimental RAO's are depressed from the theoretical curve due to the sheltering effect of the LST. The theory does not presently consider ship interaction.

b. The experimental barge surge RAO's for those tests wherein the barge was moored (Tests 1 - 6) are greater than those predicted by theory because the mooring tended to "tune" the natural surge period closer to the period band of significant wave energy. No moorings were considered in the analytical estimates.

c. The measured barge roll spectra for Tests 3 and 6 were influenced by a non-stationarity in the data due to the low period list induced by crane rotation during container unloading. Sheltering could also have had an effect on the results for Tests 1 - 6.

---

*Ideal is defined as steady, highly unidirectional narrow banded swell which was readily measureable with the Datawell buoy.

d. The experimental results for Test 7, wherein an attempt was made to head the barge crane into the oncoming swell, are suspect since considerable roll was recorded (see Figure E.32).* Theoretically no roll should be present in a true head sea. Furthermore, the large discrepancy in the results for barge surge (experimental motion lower than theoretical motion) is likely due to the restraint imposed by the towline connecting the barge and tug.

e. Since deep water added mass and damping coefficients were used in predicting the LST motion (Figure E.33), the actual motion, lower than that predicted by theory, is due to shoal water effects on these hydrodynamic properties. The smaller draft crane barge would be affected to a lesser degree.

Findings and Conclusions.

1. Instrumentation for measuring crane barge and LST motion appears to have worked well. Recorded motions, however, approached the limits of instrumentation sensitivity.

2. Analytical predictions for crane barge heave and surge agree reasonably well with measured data, but considerable discrepancy exists between measured and predicted roll and pitch.

3. Besides measurement inaccuracies, discrepancies between theory and experiment could be caused by ship hydrodynamic interaction, ship-to-ship moorings forces and shoal water effects on vessed added-mass and damping; all of which are factors not presently considered in the theory.

Recommendations.

1. Instrumentation for measuring motions aboard large vessels and platforms should be capable of accurately measuring low angular displacements (0 - 2 degrees) and linear accelerations (0 - 0.02 g's).

2. Since accurate data on wave height and period and the directional properties of the sea are mandatory for valid comparison of experimental and theoretical results, every effort should be made to obtain this information.

3. Pendulation and Lifting Measurements

An instrumentation package was installed at the center of the spreader bar for the purpose of measuring pendulation during load transfers from the LST to the causeway. The package consisted of three accelerometers connected by cable to a battery/transmitter unit. Two of the accelerometers measured components of acceleration in the plane

*In practice it is extremely difficult to precisely maintain the heading of a vessel for the minimum time period required for data taking (about 20 minutes).

of the spreader bar; the third measured accelerations normal to the spreader bar. Variations in lifting line length were measured by a device mounted to the auxiliary block of the crane. The device was comprised of a grooved wheel connected by a shaft to a linear potentiometer. By spring loading the grooved wheel, positive contact between it and one of the four lifting lines was maintained throughout the tests. A data transmission and power cable connected the line potentiometer to the recharageable battery package mounted at one end of the spreader bar. A small FM transmitter, attached to the battery package, transmitted all four channels of data to the instrument trailer parked at Green beach.

Tests Conducted. Load acceleration and changes in the lifting line length were measured and recorded for all containers transferred at sea. Generally, the instrumentation worked well, the major problem was a weak signal received during the first two container lifts made on 22 March (containers A-1 and A-2). A planned pendulation test - with no tagline restraint - was not conducted since it was concluded by the crane superintendent, crane operator and experimental investigators that this test would be unduly hazardous to personnel and equipment.

Test Results. It was readily apparent to observers that load pendulation was not a serious problem during these tests. Pendulation control was due largely to the skill of the crane operator and personnel manning the spreader bar taglines. In one instance, shortly after container A-2 was lifted from the deck of the LST, positive tagline control was lost, and the container did exhibit an appreciable amplitude of oscillation (8 - 10 feet). Control was re-established, however, and the transfer was completed without further incident. Unfortunately. reliable data on the A-2 lift was not obtained due to a weakly received signal. Although acceleration data was recorded for all but the first two container transfers, only motion due to the oscillation of the barge could be deduced from the records; hence no attempt has been made to process and present data from the pendulation experiment in this report.

Recommendation. Pendulation is recognized as a potentially serious problem for cranes having long load suspension lines; however, pendulation measurements should be attempted only if the container transfer system employed is suspected of having marginal anti-pendulation capability.

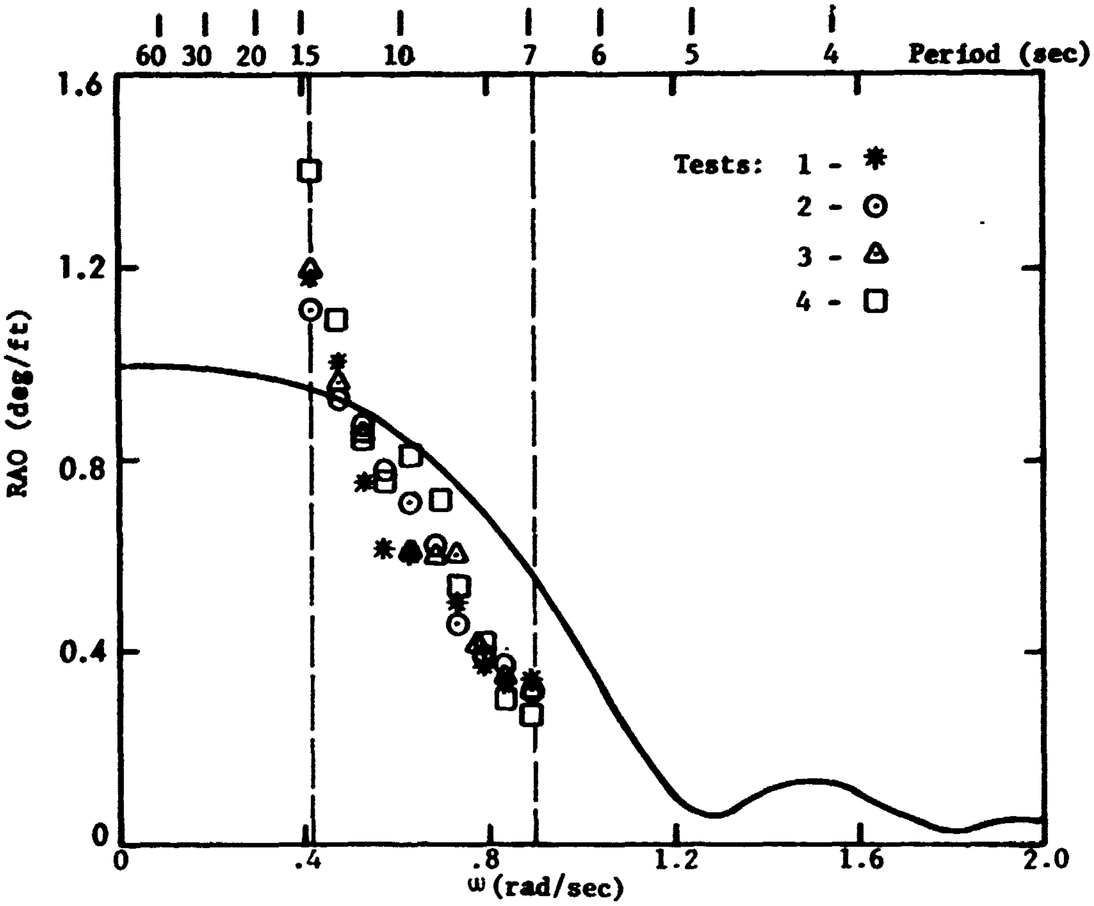


Figure E.18. Barge heave RAO for tests 1 - 4.

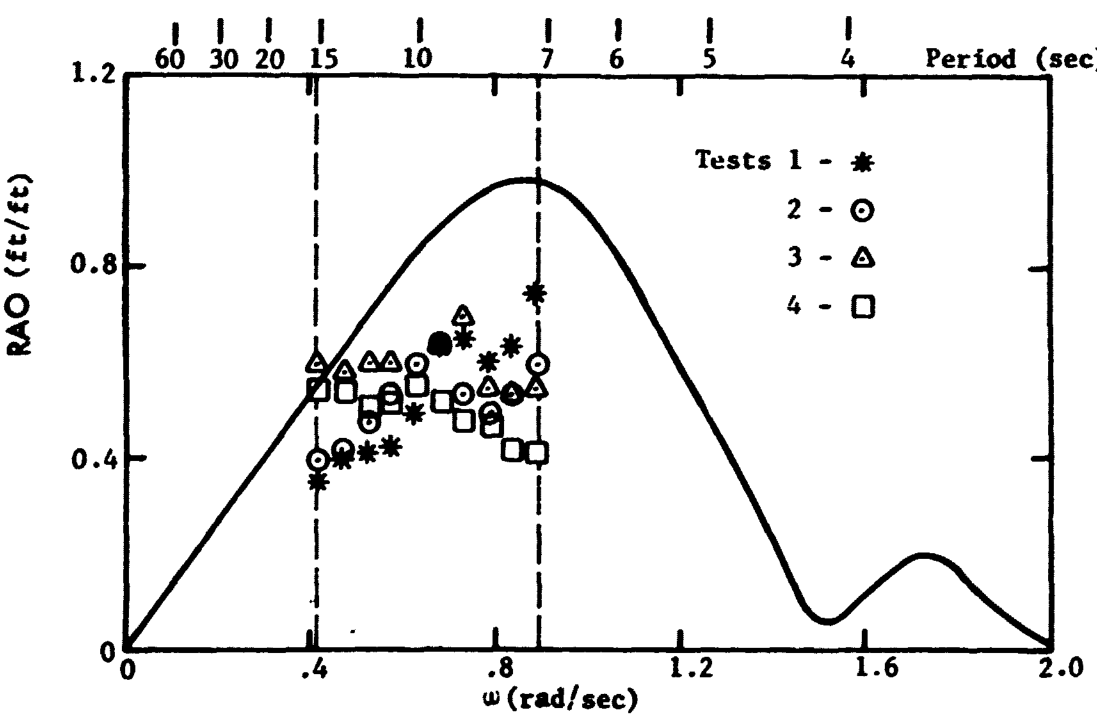


Figure E.19. Barge pitch RAO for tests 1 - 4.

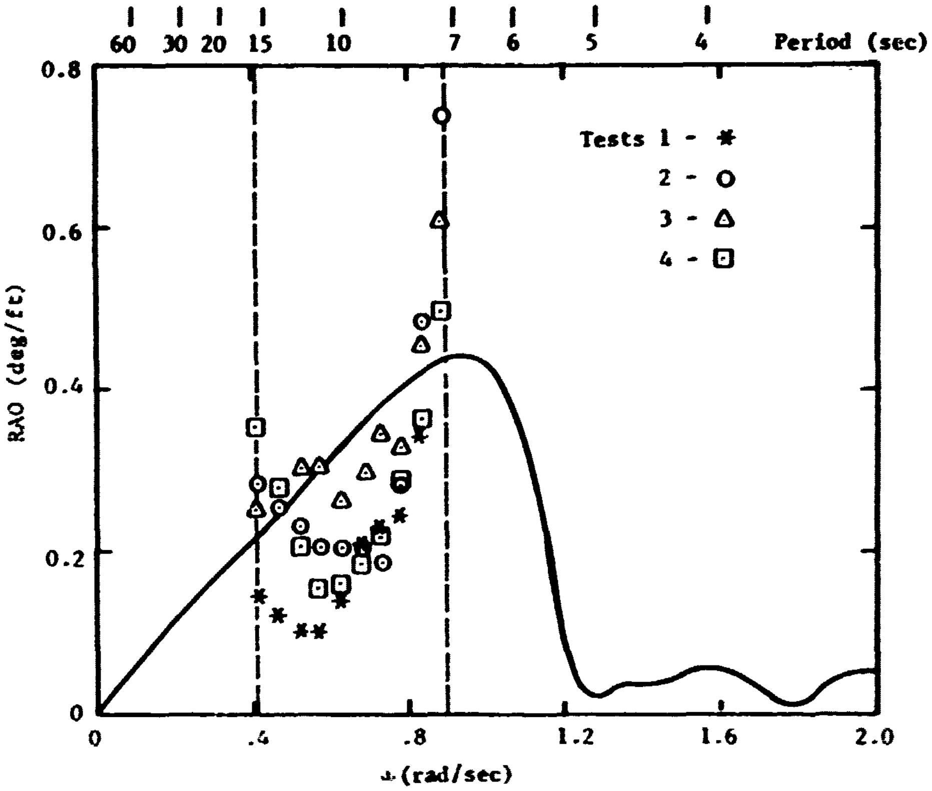


Figure E.20. Barge roll RAO for tests 1-4.

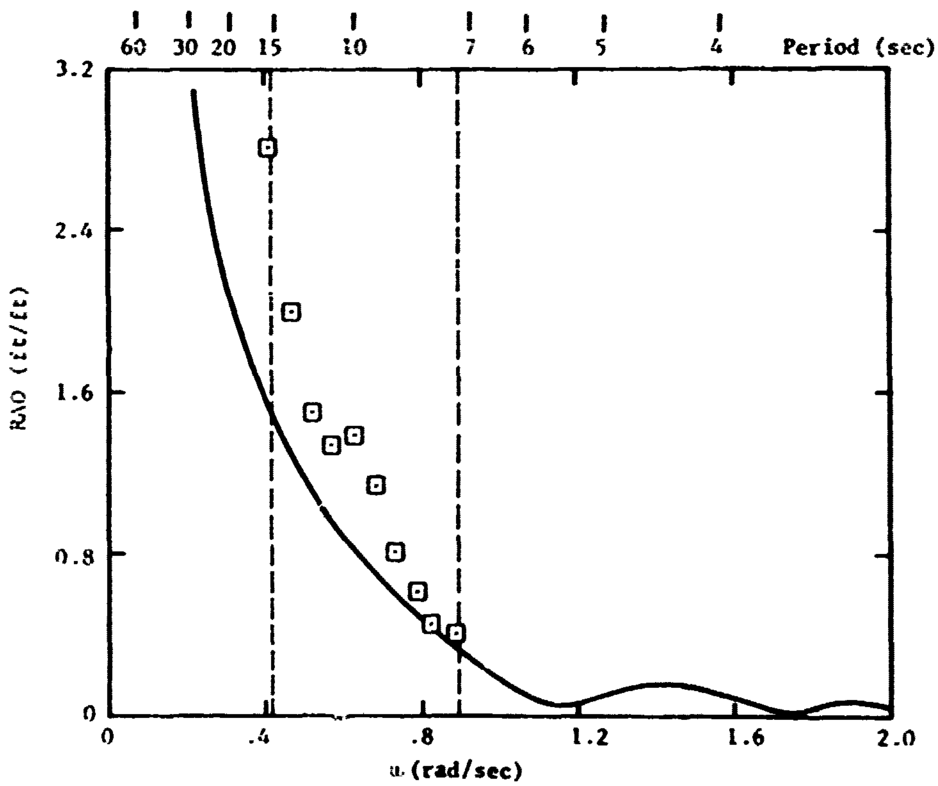


Figure E.21. Barge surge RAO for test 4.

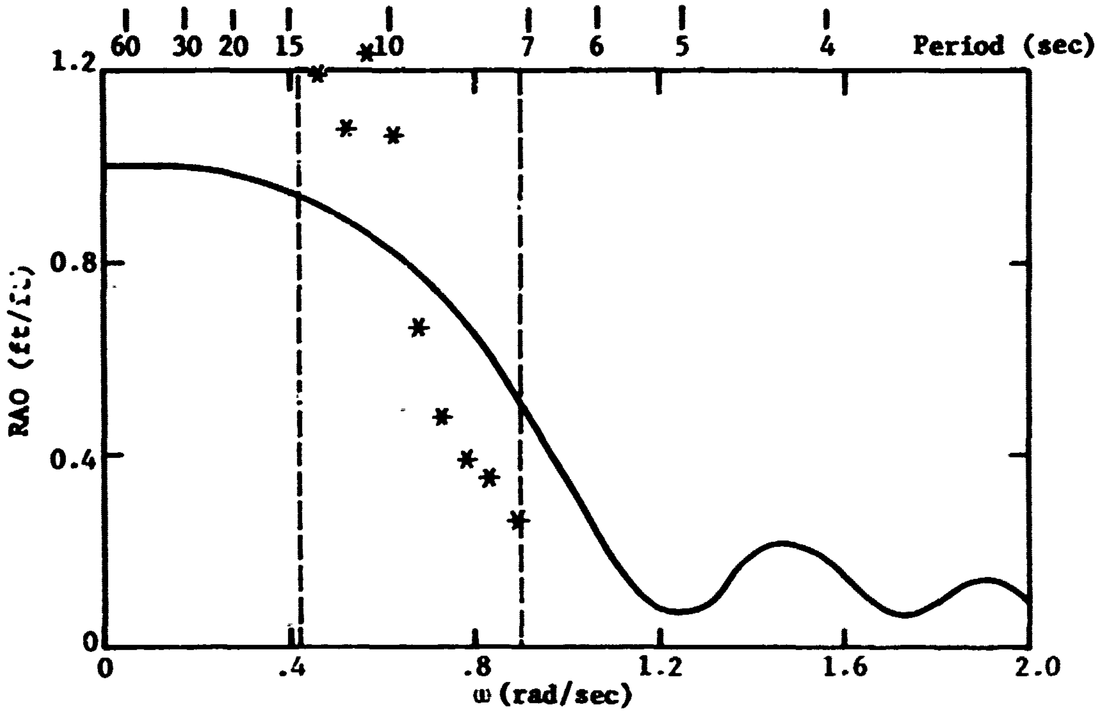


Figure E.22. Barge heave RAO for test 5.

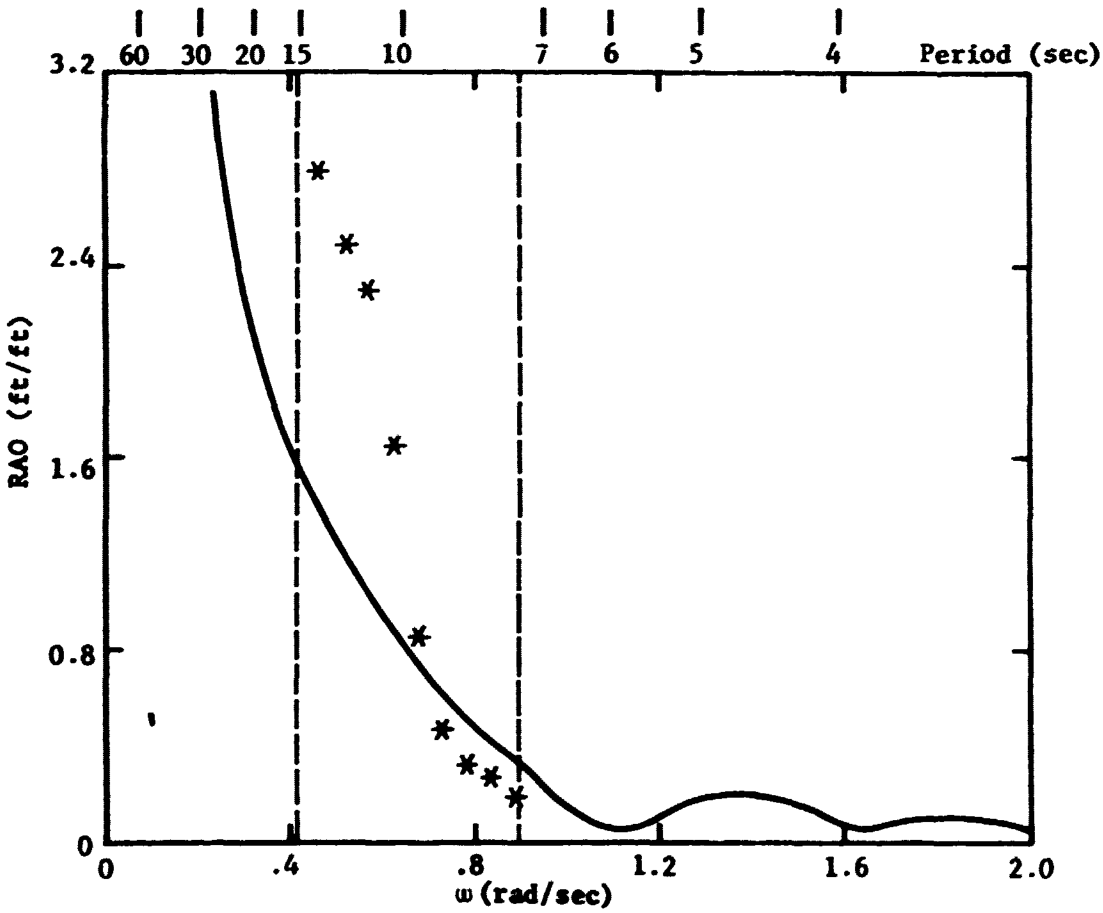


Figure E.23. Barge surge RAO for test 5.

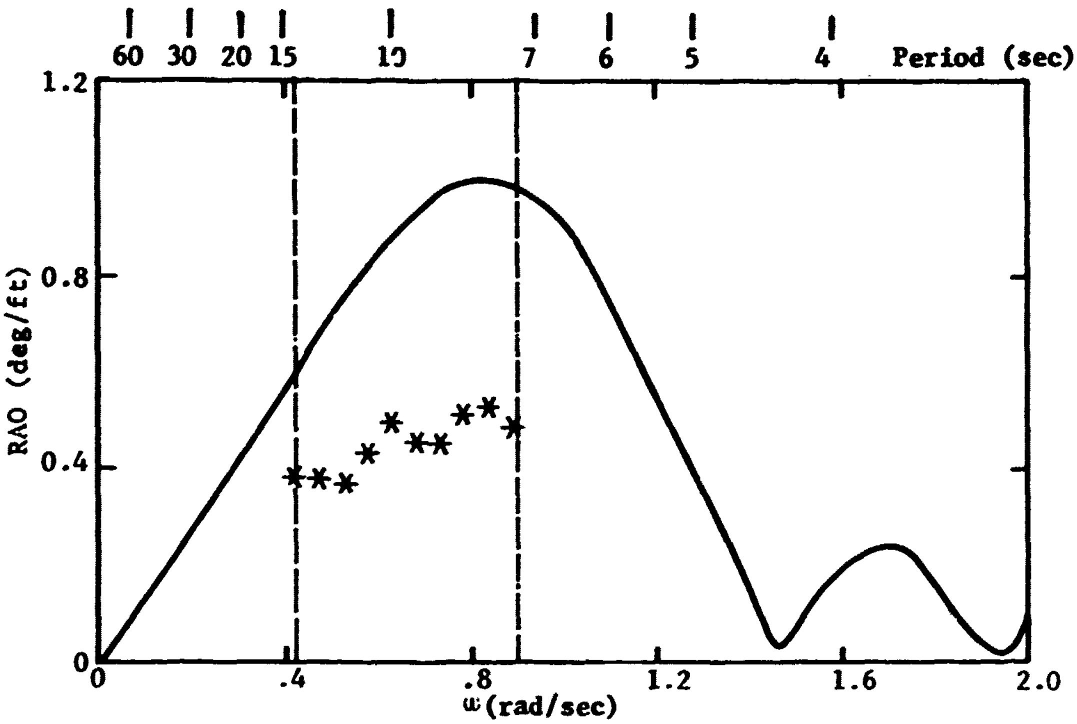


Figure E.24. Barge pitch RAO for test 5.

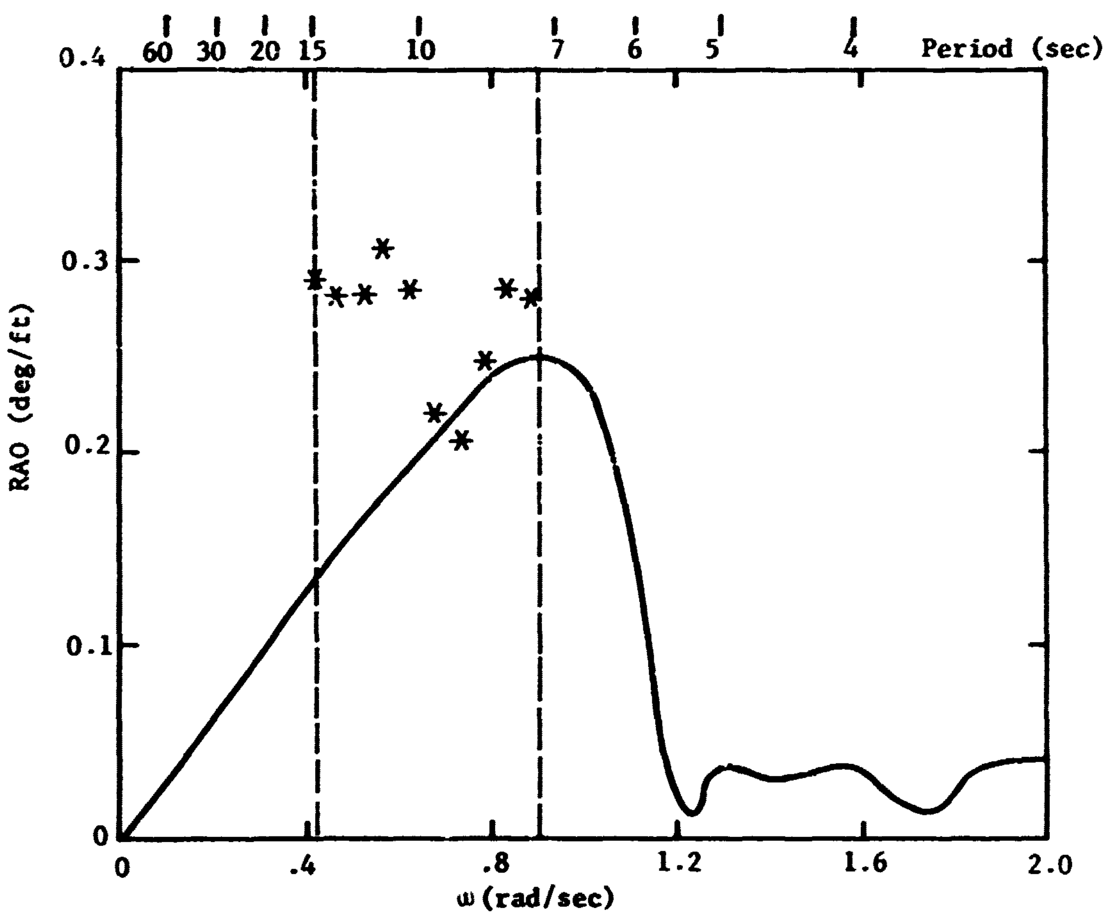


Figure E.25. Barge roll RAO for test 5.

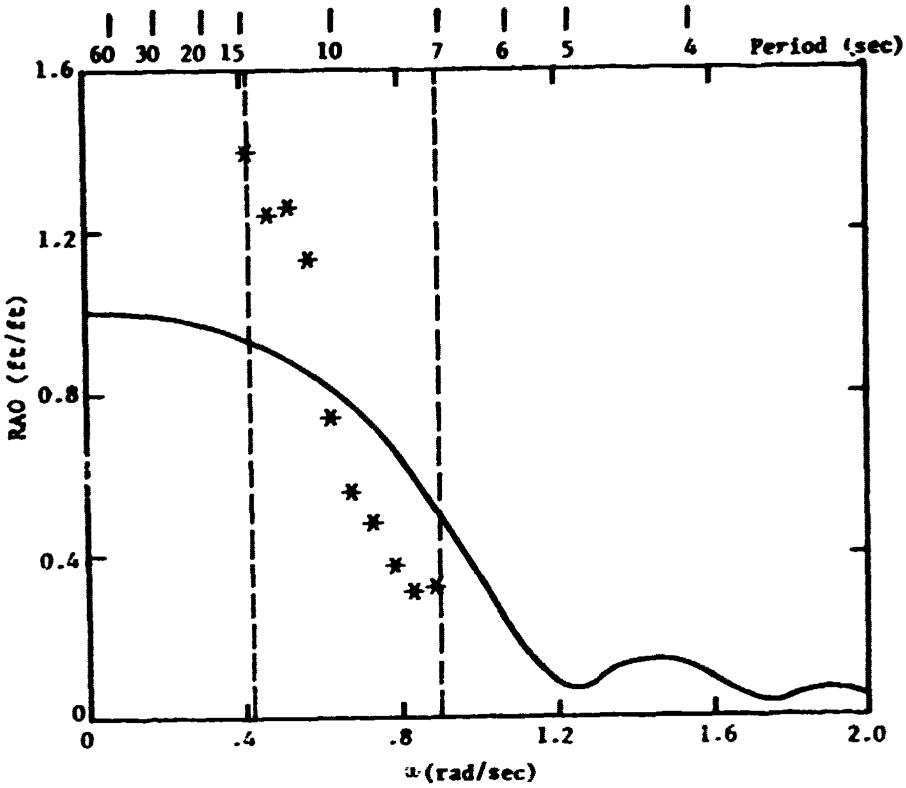


Figure E.26. Barge heave RAO for test 6.

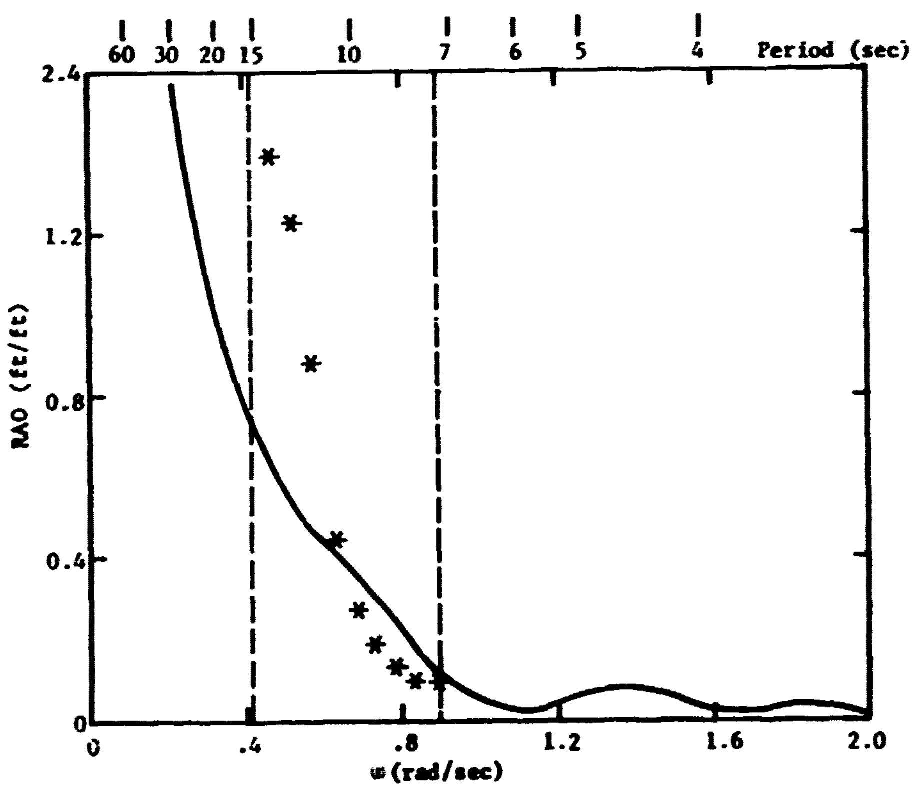


Figure E.27. Barge surge RAO for test 6.

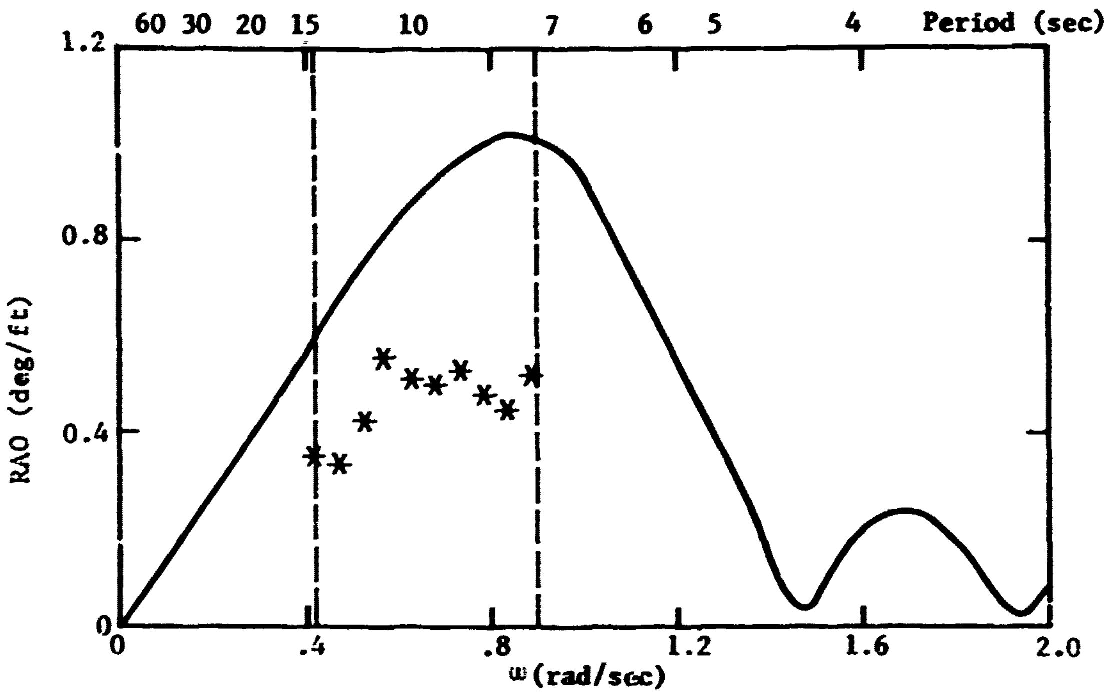


Figure E.28. Barge pitch RAO for test 6.

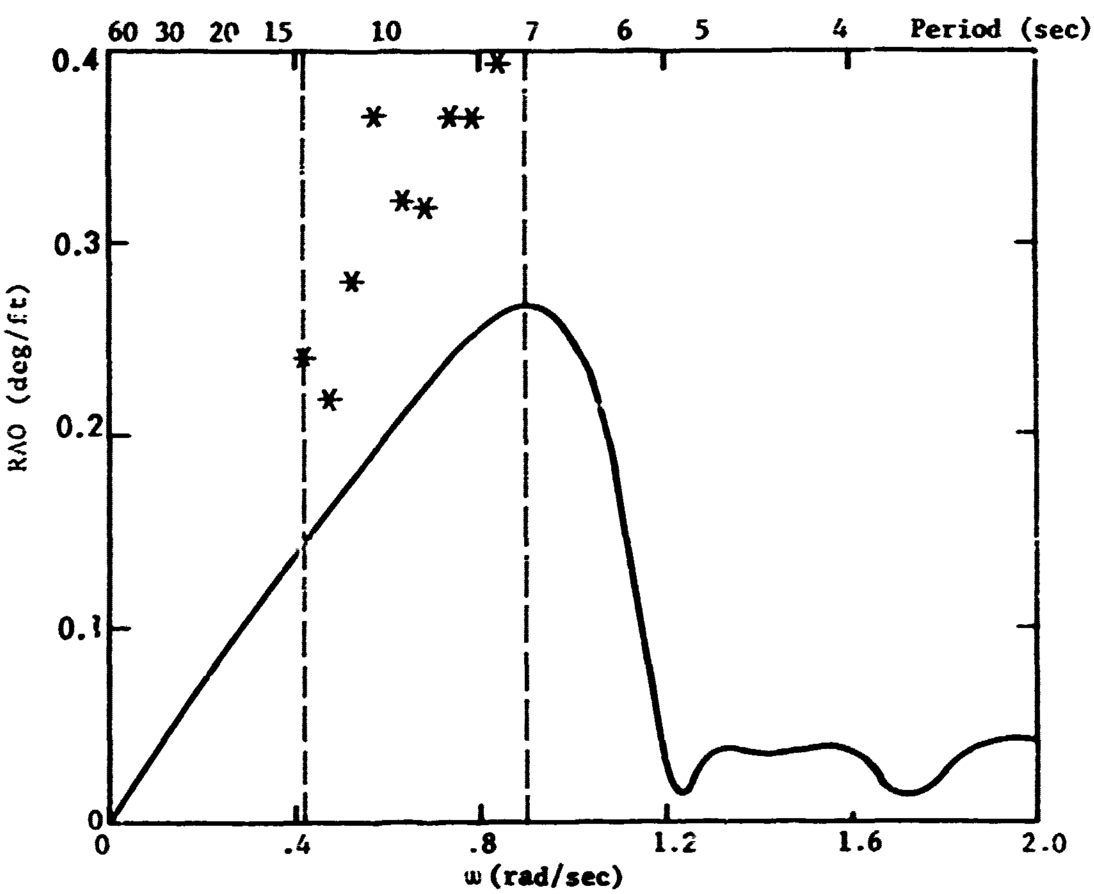


Figure E.29. Barge roll RAO for test 6.

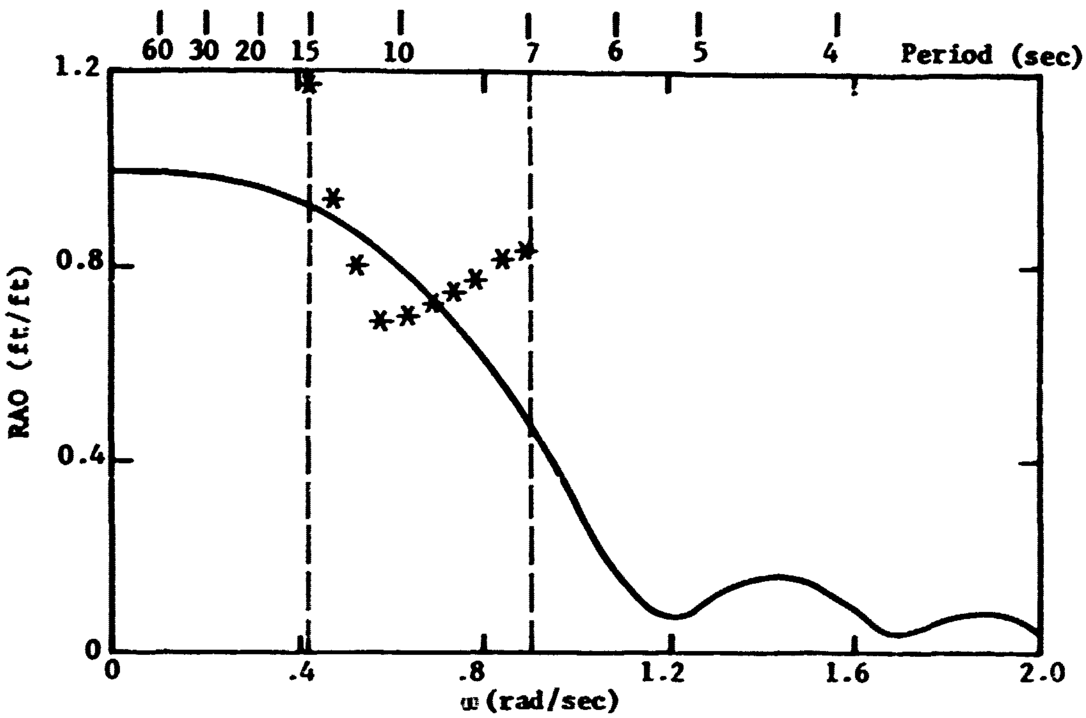


Figure E.30. Barge heave RAO for test 7.

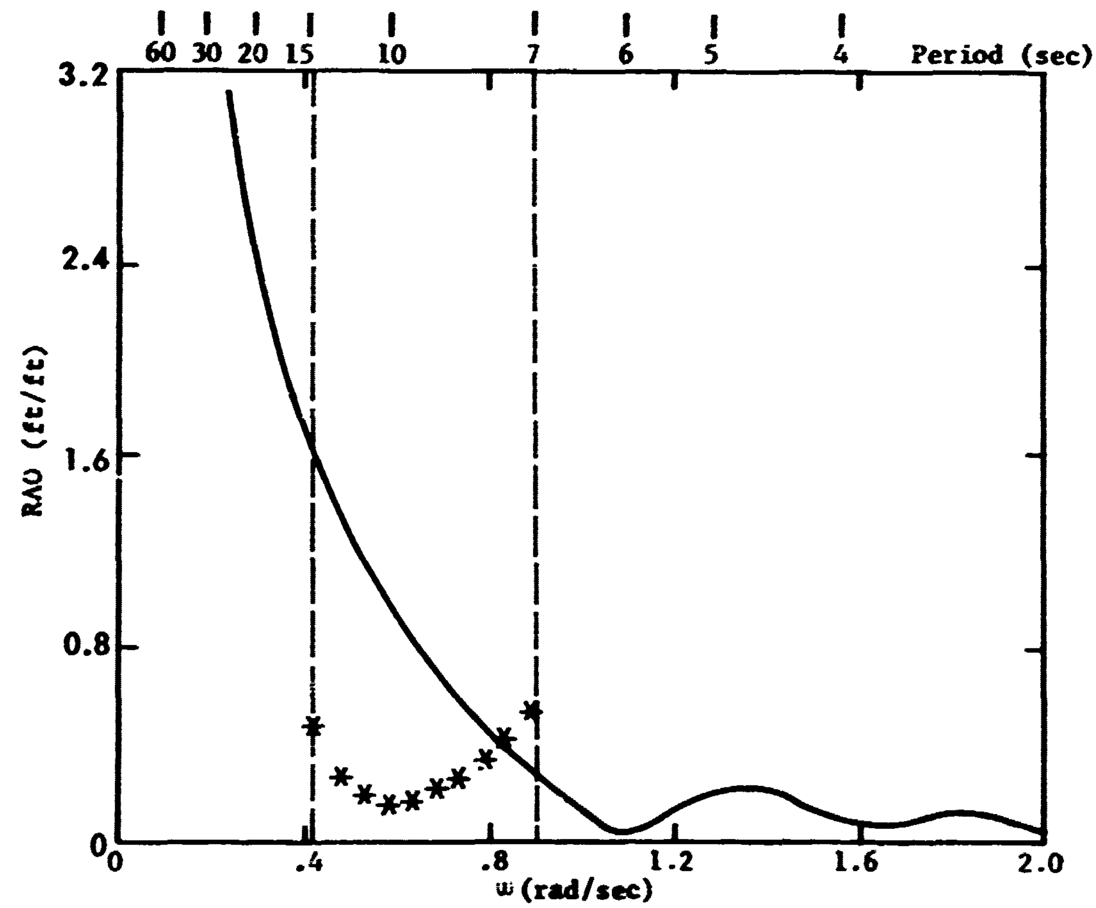


Figure E.31. Barge surge RAO for test 7.

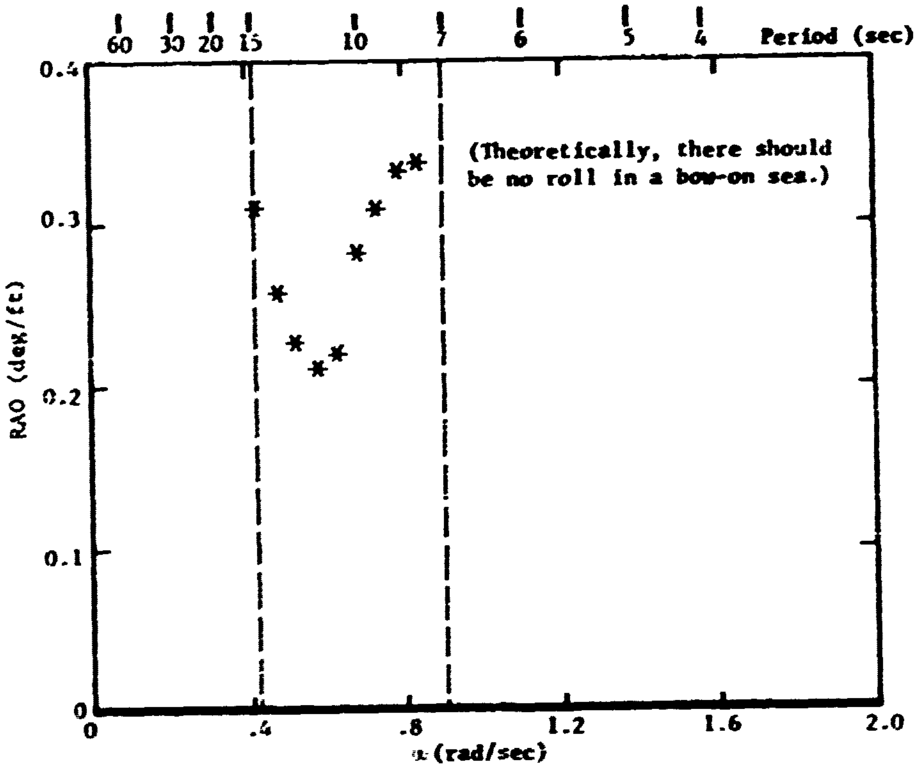


Figure E.32. Barge roll RAO for test 7.

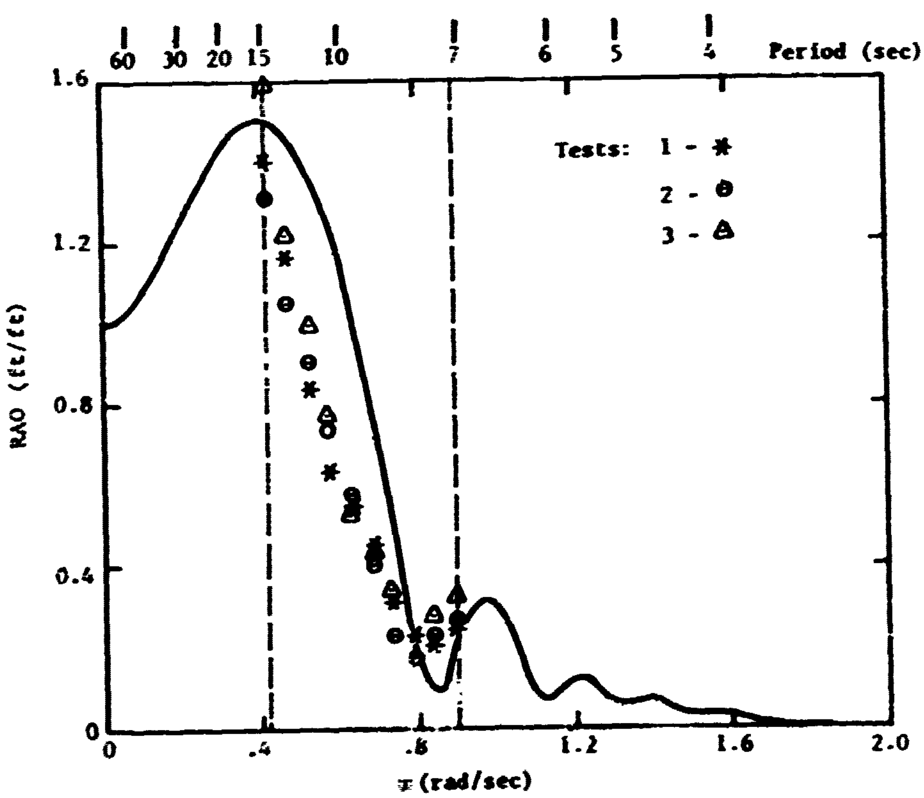


Figure E.33. LST vertical displacement RAO for tests 1 - 3.

F. SUMMARY

1. Findings

The operational reports made by the COMPHIBPAC evaluators are contained in Appendix H.2 (operational data sheets have been removed). NCEL evaluators tentatively agree with the operational findings of these evaluators but add the following related comments:

a. "The need for development of a new system" is concurred in and has been underway by the NAVFAC/NCEL Project ELF (Expeditionary Logistics Facility) for several years and the data support studies have been completed.

b. The limitation laid on by "sea state should not exceed sea state of 3-foot with a maximum of 4-foot for successful off loading operations" does not appear to exceed the operational limitations of the equipments used in these tests. The operators conducting tests on 22 and 23 March were able to move 12-ton containers in seas exceeding those described as limiting, using some equipments (crane, front lift loader) which are being studied for improvement or replacement. One important factor which must also be considered besides the swell height is the swell period and sea spectrum relative to the crane barge length/displacement. Some equipments are expected to be capable of operation in much larger wave/swell than those encountered during the tests.

c. "The limitation of the causeway ferry to end connect to the eight section causeway pier in surf/swells exceeding 7 feet" is concurred in by NCEL and indicates an area requiring a development effort. It must be remembered that this operation is an alternate to the primary concept of direct beaching/unloading which requires no end connecting procedure in the surf. This direct beaching operation appears more capable than that of existing landing craft of LST/causeway operation.

d. It is concurred in that the time phase of the container operation would follow after the assault phase. The indicated additional shipping required for the assets points out an area needing R&D study. This will be studied in detail in Project ELF. However, the time phase for container operation in ELF is being examined for needs arising as early as D+5 to D+15. Consideration is being given to the capability contained in the assault phase equipments (4 to 12 sections of causeway, landing craft, helicopters) which could be utilized during the assault phase or immediately after.

e. Staging area requirements for storage of large numbers of containers is being considered in ELF as well as the associated road surfacing. NCEL concurs with this operational observation.

f. The suggestions made by the operational evaluators relative to "containerized ship with crane aboard" and "an integral part of the system containerized ship, crane, and the conveyance to move the containers ashore" is concurred in by NCEL. These capabilities are planned and scheduled in OSDOC II in October 1972.

It is the opinion of the NCEL evaluators that:

1. The causeway shuttle concept performed its assigned shuttle/beaching mission in swell/waves exceeding the original estimated capabilities noting that this was an engineering test and that requirements for increased productivity of the system would result in system changes. The ability to end connect the causeway ferry to the moored eight section pier appears limited. The connection was made in smaller waves prior to beginning the operation on 23 March. During the test, the ends of the two units were brought together in the 7-9 foot swells and held in line for about 20 minutes. It appears that a modification to the system or procedures should be made to permit end connection in this sea condition. The 6x15 barge operated satisfactorily but should be increased in width by at least one additional pontoon string to provide additional space for the front lift loader.

2. The concept of a floating crane to unload containers in the open sea appears both feasible and practical. The direction for R&D for making all aspects of this concept practical will certainly include "availability of the crane at the objective area." The 100-ton Navy YD crane barge performed satisfactorily. However, the crane operator has had about 40 years experience. The damage occurring between the crane barge and the LST was aggravated by the swell height (up to 5.4 feet) and period (8-12 sec) but was primarily caused by inadequate fendering/mooring systems.

3. The floating crane was capable of lifting containers from the cell in the ship. Some basic criteria for development of a better crane are listed in section 3.1.

4. Wave data was obtained at the ship and beach locations.

5. Current data was obtained at the ship area.

6. Motion data on the crane barge was recorded during the operation. Instrumentation employed for measuring platform motions operated satisfactorily. However, it should emphasized that every effort be made to obtain accurate data on wave height, period and the directional properties of the sea to provide valid comparision of experimental and theoretical results.

7. Acceleration measurements were recorded using the instruments installed on the spreader bar.

8. The M52/M127 units performed all the required operations of transport during the engineering tests. The A6 bolts, cleats, and other projections on the ferries cause damage to the vehicle's tires. The vehicles should drive on the pontoon decks only and avoid the pontoon angles with their protruding A6 bolt heads.

9. The On-Fast material supported the truck/container traffic with resulting minor damage which did not interfere with the operation.

10. The Mo-Mat performed satisfactorily and was easily installed at the beach end of the causeway for truck traffic.

11. Tests on the vacuum pads were inconclusive.

12. Rubber fenders on the 6x15 barge appear to function properly, but were not compatible with the large ribs on the crane barge. No apparent damage was observed between the 6x15 barge and the crane barge.

13. The power tagline was not entirely successful due to faulty equipment, but did provide assistance to the tagline crew, steadied the container in the wind and provided a dampening effect on pendulation. The power tagline could be improved as detailed in Section B.2.

14. The spreader bar operation could be improved by modifying it as described in Section B.3.

2. Discussion

As planned for these tests, productivity was not a test goal and as shown in Table A.3, the total time to move 4 containers was about 110 minutes. However, of this total time, 65 minutes was delay time waiting for the ferry to shuttle. This delay can be eliminated by increasing the length of the ferries (more containers loaded) or by increasing the number of ferries.

Use of a crane barge similar to the 100-ton capacity YD-193 is not planned in the final NCEL concept because of its obvious limitations, e. g., mobility problems, small barge displacement which tends to produce large barge motions in increasing sea swell heights and periods, and lower than desired boom-line speeds. However, the unexpected relative success of this crane barge to move 12-ton containers in the sea conditions existing at the Coronado tests indicated that in the absence of a better system, this type YD barge crane has a significant capability to be exploited.

The vacuum pads were proposed as a method to secure the pontoon barge or other craft to the containership (breast lines) where a large variation in deck height exists. This large difference in deck levels creates a problem in tying a craft with lines so that it does not separate from the ship during cargo transfer. The vacuum pads being secured slightly above the deck level of the barge should provide a positive breast line operation. Because the vacuum pads lose holding capacity as the load angle varies from the perpendicular to the pad, the lines were planned to be secured to a slide line on the pontoon barge. Use of the slide would provide continuous tension between the ship and barge but allows the barge to surge without loading the pads. Spring lines would be required to resist surge.

It was observed that the crewman handling the taglines could not be expected to signal the crane operator. A separate signalman is required making a minimum of a 5-man crew on each platform. Also observed was the necessity for extra long hand taglines to facilitate passing/controlling the container from the LST deck to the crane barge deck to the 6x15 barge deck. And in conjunction with this operation, there was a lack of bitts/cleats in strategic positions to permit ready hand tagline operations by the crewman.

G. RECOMMENDATIONS

It is recommended that the floating crane/causeway ferry shuttle concept be further evaluated at OSDOC II, Fort Story.

Specifically positioned cleats should be provided on the 6x15 barge, ship and crane barge for use with the hand taglines.

A five man crew (one man for each of four taglines and one signal man) should be provided on each platform to handle the containers.

The front lift loader should have a top lift spreader bar which is mechanically powered for side movement under load.

The fender/moor systems between the ship/crane barge/platform barge should be examined carefully relative to the physical compatibility of the equipments.

Appendix H1

OPERATIONAL SCHEDULE

Preliminary Tests
March 1972

OSDOC II

ENGINEERING TESTS

CORONADO, CALIFORNIA

NAVAL CIVIL ENGINEERING LABORATORY
PORT HUENEME, CALIFORNIA 93043

23 Feb 1972

BACKGROUND

The Department of the Army conducted an Offshore Discharge of Containership (OSDOC I) exercise in 1970 to demonstrate the capabilities and problems associated with the unloading of a self-sustained containership (i. e., a ship with a permanent crane aboard) in the open sea. The Navy provided some technical observers for this operation which occurred off the coast of Fort Story, Virginia in December 1970. A report[1] of this operation has been made.

As a follow-on to OSDOC I, the Army planned to conduct a further operational evaluation (OSDOC II) of the offshore discharge of a non-self-sustaining containership (i. e., no permanent crane aboard) during October 1972 and accepted the Navy's proposal of assistance and participation in this exercise. The intent of the exercise is to use existing military or commercial equipments to discharge containers ship to shore and from an analysis of the results to provide direction to future research and development efforts.

Authorization[2] for the Navy to participate in OSDOC II was made by the Chief of Naval Operations and an Evaluation Planning Committee, Table 1, was established. The Committee coordinated and developed the OSDOC II test objectives, enclosure (1).

The Naval Civil Engineering Laboratory (NCEL) was designated as the lead Navy laboratory with responsibility in planning, pre-testing, and evaluating the floating crane/causeway ferry/beach components of the Navy's test objectives for OSDOC II. NCEL proposed to offload 8'x 8' x 20' containers from a non-self-sustaining containership using a floating crane, transfer the containers to shore on truck/trailers via 4-section pontoon causeway ferries and roll off the truck/trailers by fork truck (or crane) and unstuff the container contents by fork truck.

Some primary problem areas encountered in OSDOC I were (1) the relative motions between the landing craft and crane/container, (2) alignment and placement of the container onto the trailer in the landing craft, (3) a sand bar at the landing site which restricted landing craft operation, and (4) removal of the container/trailer from the landing craft at the beach.

---

[1] Army/Navy Test of Off-Shore Discharge of Containership, 5 - 9 December 1970 by M. E. Essoglou, NAVFAC.

[2] CNO ltr OP-404F/kss Ser 804P404 of 27 Sep 1971.

These problem areas were to be alleviated or eliminated by the following features of the NCEL concept, i. e., (1) the container is placed onto a large pontoon barge by the crane to eliminate the restricted area of the landing craft, (2) the container is placed on a trailer by a fork truck to eliminate the alignment and relative motion problems, (3) a moored pontoon causeway will be pre-positioned over a sand bar hazard and the pontoon ferry connected to the offshore end, and (4) the truck/trailers will be driven forward off the causeways at the beach to eliminate container handling problems in the surf.

The operational problems anticipated with the NCEL concept were planned to be tested prior to the OSDOC II exercise. An engineering test program was established to occur at Coronado, California in March 1972.

ENGINEERING TESTS - CORONADO

These tests are being conducted for purposes of evaluating the operational capabilities and limitations of the NCEL concept. The Commander, Amphibious Forces Pacific Fleet has been tasked to support the test operation at Coronado and has provided the USS RACINE LST 1191 to perform the function of the containership. Naval Beach Group ONE and Amphibious Construction Battalion ONE will provide the personnel and equipment to conduct the cargo shuttle operation. The 100-ton barge crane will be provided and operated by the Public Works Center, U. S. Naval Station, San Diego. The U. S. Marine Corps, Camp Pendleton will provide the truck/trailers and drivers to transfer the containers and will install and operate a pressure transducer in the surf area to measure the wave heights at the landing site. A surface riding wave gage (provided by Oceanographic and Geodetic Branch, PMR, Point Mugu, California, and a current meter furnished and monitored by Louisiana State University Coastal Studies Institute, Baton Rouge, Louisiana) will be installed at the ship area. An over flight of the open sea test site to photograph the wave formations will be made under the auspices of the ONR Liaison Officer, Scripps Institute of Oceanography, La Jolla, California. Equipment to measure the barge crane motions will be provided by the Naval Ship Research and Development Center, Carderock, Maryland. Two hardstands, about 100'x100' each, will be installed on Green beach for the Phase II tests; the first hardstand of AM-2 matting will be placed by MCB-5, 31st NCR during the period of 6-8 March, and the second hardstand of On-Fast material will be placed by ACB-ONE/NCEL during the week of 13 March.

The engineering tests will develop the following information:

1. Operational capability of the causeway ferry/6 x 15 barge concept (includes moored causeway operation to cross sand bar areas).
2. Operational capability of the 100-ton Navy YD type barge crane in calm water and open sea to handle containers.
3. Ability of floating crane to lift container from cell to ship.
4. Wave data at ship and beach locations.

5. Current data at ship location.
6. Motion data on crane barge.
7. Acceleration data on spreader bar.
8. M-52/M-127 (also M-213/M-127) ability to transfer containers from causeway across beach.
9. Capability of On-Fast to support truck/container on sand area.
10. Capability of Mo-Mat to support truck/container across sand area.
11. Capability of vacuum pads to tie barge to ship.
12. Capability of rubber fenders to protect crane barge and 6 x 15 barge.
13. Capability of power tag line on crane to control container.

Operation Safety

A safety director will be responsible for the overall safety of the operation.

All personnel working with or handling containers will wear protective head gear, gloves, and hard-toe shoes.

Life preservers will be worn by cargo handlers and other personnel aboard the loading platform, crane, tugs, and causeway ferries.

In the event of a safety hazard should arise, which could result in the loss of limb or life or damage to equipment, the official in charge of the equipment/operation may cease this operation until the safety director or his designated representative may make a determination either to continue or terminate the operation.

A safety boat and swimmers (UDT-12) will be stationed at appropriate areas to assist personnel in the water.

Communications

A radio communication system will be provided for the engineering tests.

Personnel

A list of the assigned personnel are contained in Table 2.

Engineering Tests

The engineering tests will be conducted in two phases; first phase will be conducted in San Diego Bay, Figure 1, and the second phase will be in the open sea. The 15 containers will be delivered to PWC, San Diego during the week of 1 March 1972 for stuffing. Two containers will be stuffed to a gross weight of 20 tons and thirteen (13) containers will be stuffed to a gross weight of 10 tons. The weights should be distributed uniformly in the containers and the weights are to be

secured within the container. The LST moor in the open sea (3,000-pound STATO preset to 30,000 pounds) and LCU bow moor (for current measurements) will be installed during the week of 13 March by ACB-ONE. During the second phase of the tests, a report of surf conditions at the beach landing site will be provided beginning at 0530 and repeated at 2 hour intervals. These early morning reports by UDT-12 will be used to predict the afternoon weather at the ship based on previous experience of weather in the area.

First Phase

13-14 March	1.	The container cell will be installed in the LST 1191 hatch. Following installation of the container cell, twelve containers (one-20 ton, eleven 10-ton) will be deck loaded (Figure 2) on LST 1191 by PWC and three containers (one 20-ton, two 10-ton) will be loaded into the container cell with the 20-ton container on the bottom. For the harbor tests, lashing of the containers to the deck does not appear necessary.
14 March	2.	The vacuum pads will be loaded aboard the LST.
14 March	3.	The LST 1191 will be moored to buoys No. 49-50 in San Diego Bay, Figure (1).
14 March	4.	The 100-ton barge crane No. 193 will proceed to the LST 1191 and tie along the port side as shown on Figure (3).
15 March 0800	5.	The 6 x 15 pontoon loading platform is secured to the crane barge (as per Figure 3).
15 March 0800-0845	6.	One causeway ferry will be loaded with four (4) M-52/M-127 truck/trailers at the loading ramp (point A, Figure 1) and will be towed by two warping tugs to the 6 x 15 loading platform for end connecting.
15 March 0845	7.	Upon approach the LST/6 x 15 loading platform, the warping tug adjacent to the LST will drop off and move to the far end of the causeway to assist in making the end connection.
15 March 0900-0915	8.	The wire rope bridle will be passed from the causeway/warping tug to the 6 x 15 barge and the warping tug winch will complete the end connection between the causeway and the 6 x 15 barge.

15 March 0800-0900	9.	The second causeway ferry (empty) is end connected to the open end of the 6 x 15 barge. Again the warping tug adjacent to the LST will drop off upon approaching the LST and assist in completing the end connection to the 6 x 15 barge as in paragraphs 7 and 8.
15 March 0900-0910	10.	The 100-ton crane, using the spreader bar, will move a container, No. A-1, Figure 2, from the LST deck to the deck of the 6 x 15 barge and return for another container off the LST. The spreader bar may be connected to the next container however no lift is made until the signal has been received that the 6 x 15 barge is cleared of the previous container and the front lift fork truck has moved clear of the container touch down area.
15 March 0910-0920	11.	The front lift loader will lift the container and move to the M-52/M-127 load position.
15 March 0920-0925	12.	A M-52/M-127 will drive from the causeway ferry to the load position at the front lift loader.
15 March 0925-0935	13.	The container is loaded onto the M-127 trailer and lashed in position.
15 March 0935-0940	14.	The M-52/M-127 drives forward to the second causeway ferry.
15 March 1020	15.	This loading operation is repeated until 4 containers, A-1 through A-4, Figure 2, have been transferred from the LST to the second causeway ferry.
15 March 1020	16.	The causeway ferry with containers is disconnected from the 6 x 15 barge and moved away, using the attached warping tug. (See item 22.)
15 March 1020-1050	17.	The standby warping tug ties to the causeway ferry and the two warping tugs move the equipment to the unloading ramp (Point A, Figure 1) where the trucks are driven ashore and unloaded using the 25-ton mobile crane. The warping tugs use the outboard propulsion units (turned 90 degrees) to control causeway alignment and the inboard propulsion units hold power ahead to hold the causeway ferry to the ramp.

15 March 1050-1055	18.	The four (4) remaining empty trucks (standing by when the causeway ferry hits the ramp) are driven aboard the causeway ferry when the last loaded truck clears the causeway.
15 March 1055-1125	19.	The causeway ferry with four (4) empty M-52/M-127 units is returned to the 6 x 15 barge.
15 March 1135-1235	20.	Four (4) more containers (H1, H2, H3, and F3) on the LST are unloaded as per paragraphs 10 through 17.
15 March 1235	21.	After the first eight (8) containers are removed from the LST, these tests are secured.
15 March 1025-1125	22.	During the interval when the causeway ferries are shuttling, tests will be conducted on the container cell. The spreader bar will be changed (to remove guides) and the barge will lift the containers from the cell and position them on the LST deck in the spaces previously occupied by containers A1, A2, and A3.
16 March 0800	23.	Causeway ferries are converted to 3 sections each (ramp section removed). Ramp section moored to concrete camp unloading site.
16 March 0800-0900	24.	One causeway ferry will be loaded with 3 truck/trailers at the loading ramp (Point A, Figure 1) and will be towed by tugs to the 6 x 15 platform for end connecting.
16 March 0800-0845	25.	One causeway ferry (empty) is end connected to the open end of the 6 x 15 barge.
16 March 0900-1000	26.	Three containers (C1 through C3) will be moved from the ship to the trailers as per paragraphs 10 through 15.
16 March 1000-1030	27.	The 3-section causeway ferry with containers is moved to the moored ramp sections (at Point A, Figure 1) and end connected. The truck/trailers are driven ashore.
16 March 1035-1125	28.	The 3 remaining empty trucks are driven aboard the causeway ferry and the sections are returned to the 6 x 15 barge.

16 March 1125-1300	29. Three more containers (F1, F2, and F4) are unloaded as per paragrapchs 10 through 15. After these containers are unloaded at the concrete ramp, operations are secured.
17 March 0800-1200	30. Back load containers onto the LST using causeway ferries to move the truck/containers from the concrete ramp to the 6 x 15 barge. The floating crane will lift the containers directly from the trailer to the LST. Operations will be secured after containers are deck loaded and lashed in place. See enclosure 2.
17 March 1500	31. A critique of the weeks operation will be held.

<u>Second Phase</u>

20 March 0800	32. The 100-ton barge crane will be moved to the moor at Ballast Point. The pontoon equipments will be moved to the beached landing site and installed.
21 March 0600	33. The LST 1191 will moor to the preset mooring and will use the LST bow anchor for a bow-stern moor (heading 242 degrees true north).
21 March 0500-0700	34. The barge crane will proceed to the LST moor area and secure to the LST, Figure 4.
21 March 0800	35. The wave buoys and current meter at ship and wave gage at surf will be installed.
21 March 0800	36. The 6 x 15 barge will be secured to the crane barge.
21 March 0800-0900	37. One causeway ferry will be loaded with four (4) truck/trailers at the beach landing site and will be towed to the 6 x 15 loading platform and end connected.
21 March 0800-0845	38. The second causeway ferry (empty) is end connected to the 6 x 15 barge, the warping tug adjacent to the LST will drop off upon approaching the LST and assist in completing the end connection to the 6 x 15 barge as in paragraphs 7 and 8.

21 March 0845-0855	39.	The 100-ton barge crane will move a container, No. A1, Figure 2, from the LST deck to the deck of the 6 x 15 barge and return for another container off the LST.
21 March 0905-0930	40.	A M-52/M-127 will drive from the causeway ferry to the load position at the front lift loader.
21 March 0930-0940	41.	The container is loaded onto the M-127 trailer and lashed in position.
21 March 0940-0945	42.	The M-52/M-127 drives forward to the second causeway ferry.
21 March 1030	43.	This loading operation is repeated until 4 containers (A1 through A4, Figure 2) have been transferred from the LST to the second causeway ferry.
21 March 1035	44.	The causeway ferry with containers is disconnected from the 6 x 15 barge and moved away, using the attached warping tug. (See item 50.)
21 March 1035-1100	45.	The standby warping tug ties to the causeway ferry and the two warping tugs move the equipment to the beach landing site where the trucks are driven ashore and unloaded using the 25-ton mobile crane. The warping tugs use the outboard propulsion units (turned 90 degrees) to control causeway alignment and inboard propulsion units hold power ahead to hold the causeway ferry to the beach.
21 March 1100-1110	46.	The 4 remaining empty trucks (standing by when the causeway ferry hits the beach) are driven aboard the causeway ferry when the last loaded truck clears the causeway.
21 March 1110-1155	47.	The causeway ferry with 4 empty M-52/M-127 units is returned to the 6 x 15 barge.
21 March 1155-1255	48.	Four more containers (H1, H2, H3 and F3) on the LST are unloaded as per paragraphs 39 through 45.
21 March 1410	49.	After the first eight containers are removed from the LST, these tests are secured.
21 March 1035-1155	50.	During the interval when the causeway ferries are shuttling, tests will be conducted on the container

21 March 1035-1155 (Cont)	50.	cell. The spreader bar will be changed (to remove guides) and the barge crane will lift the containers from the cell and position them on the LST deck. See enclosure 2.
21 March 1410-1500	51.	The crane barge and pontoon shuttle equipment are removed from the LST. Motion tests will be conducted on the crane barge after it has been removed from the LST (enclosure 3, pg. 3, para. 3).
22 March 0800	52.	Causeway ferries are converted to 3 sections each (ramp section removed).
22 March 0800-0900	53.	One causeway ferry will be loaded with 3 truck/trailers at the beach landing site and will be towed by tugs to the 6 x 15 platform for end connecting.
22 March 0800-0845	54.	One causeway ferry (empty) is end connected to the open end of the 6 x 15 barge.
22 March 0900-1000	55.	Three containers (C1 through C3) will be moved from the ship to the trailers as per paragraph 39 through 44.
22 March 1000-1045	56.	The 3-section causeway ferry with containers is moved to the moored causeway at the beach and end connected. The truck/trailers are drive ashore.
22 March 1050-1145	57.	The 3 remaining empty trucks are driven aboard the causeway ferry and the sections are returned to the 6 x 15 barge.
22 March 1145-1330	58.	Three more containers (F1, F2 and F4) are unloaded as per paragraphs 55 and 56.
22 March 1000-1030	59.	Load pendulation tests using 10-ton container will be made by repeatedly raising and lowering the container at a constant rate (minimum of 10 lift cycles), (enclosure 3, pg. 3, para 4).
22 March 1030-1200	60.	Conduct crane barge motion tests (without container operation) with barge in lee and seaward side of LST (enclosure 3, pg. 3, para 2).
23 March 0800-1300	61.	Operational tests not completed on 21 and 22 March will be conducted this date. Operations are secured upon completion of tests.
24 March 0900	62.	A critique of the weeks operation will be held.

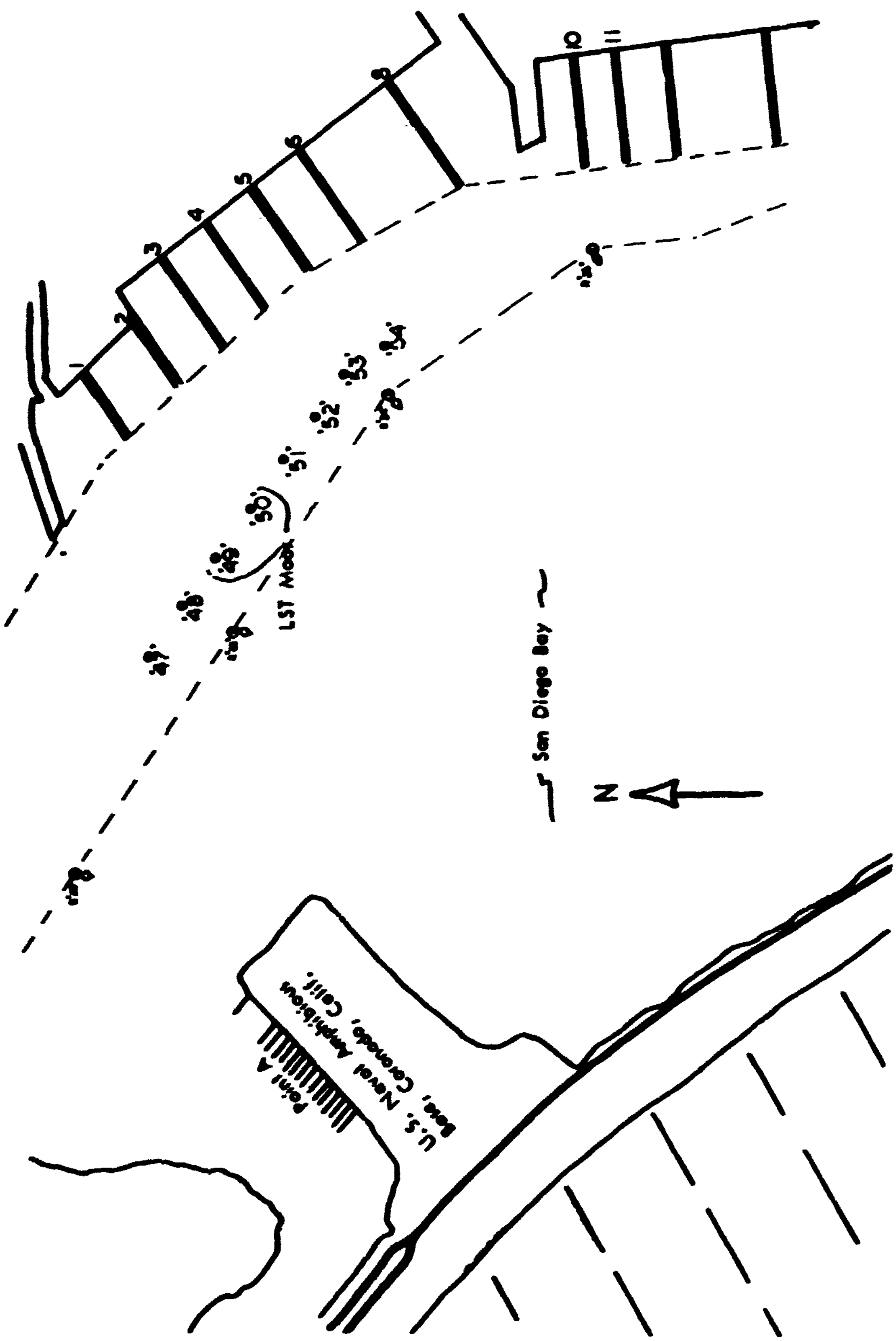


Figure 1. Phase I test.

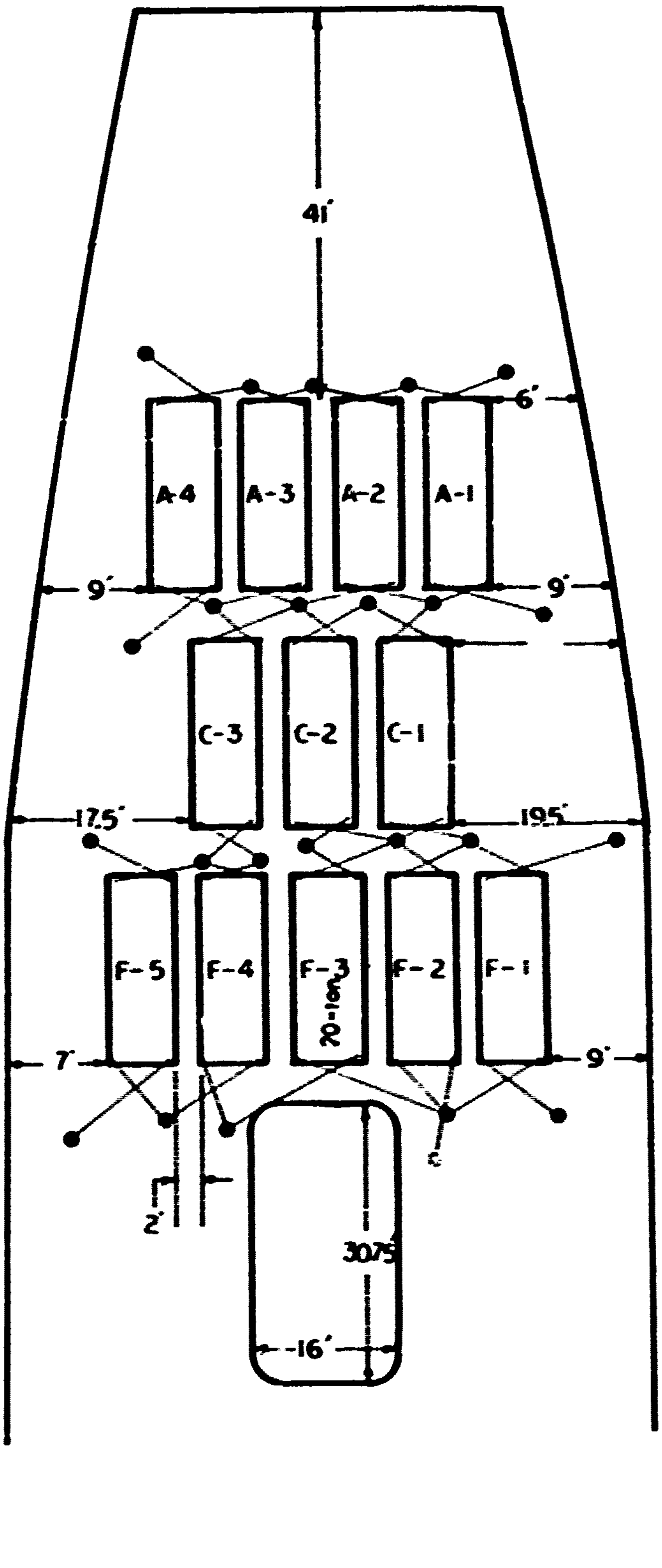


Figure 2. LST deck plan for containers.

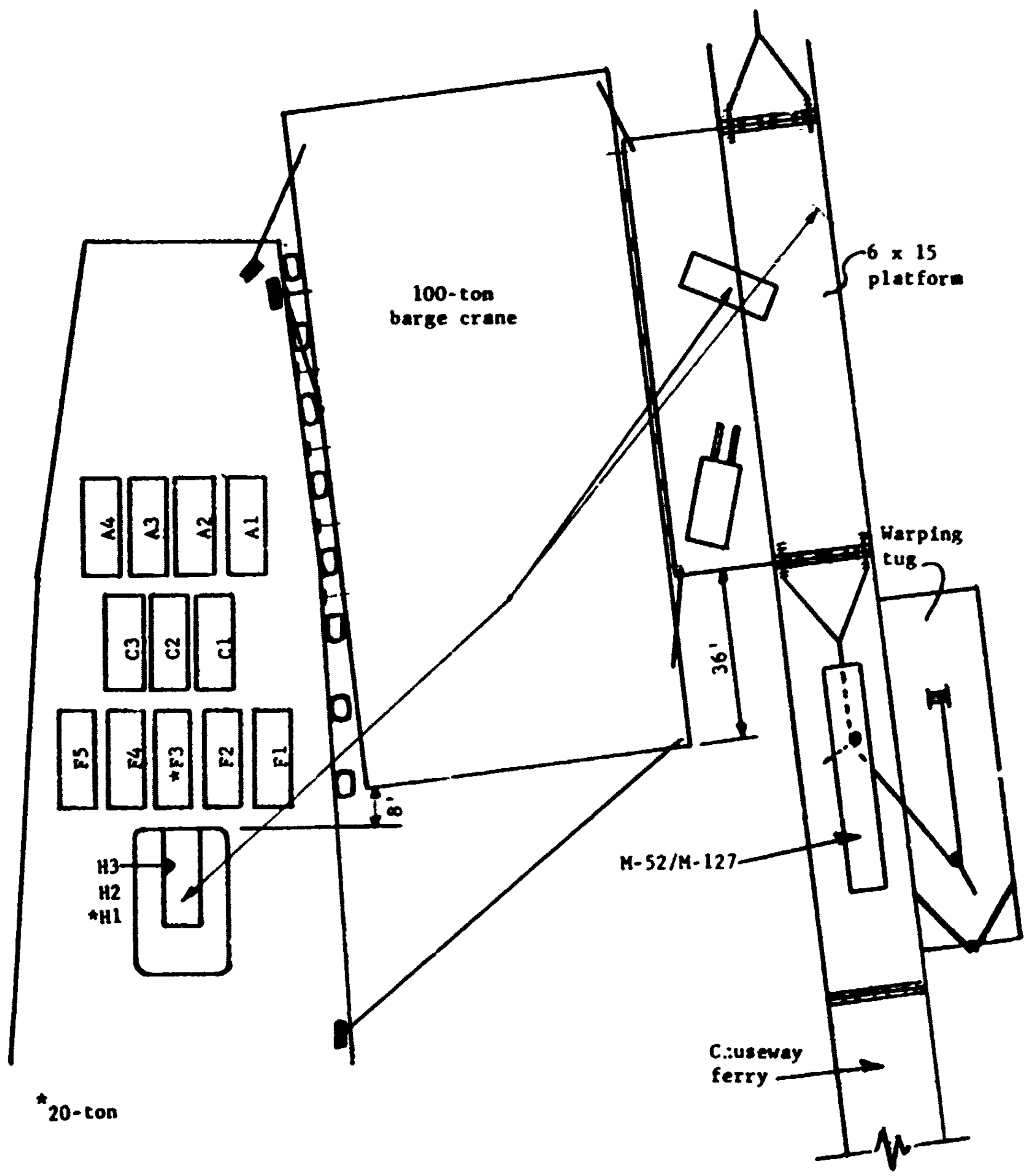


Figure 3. LST/Crane barge location.

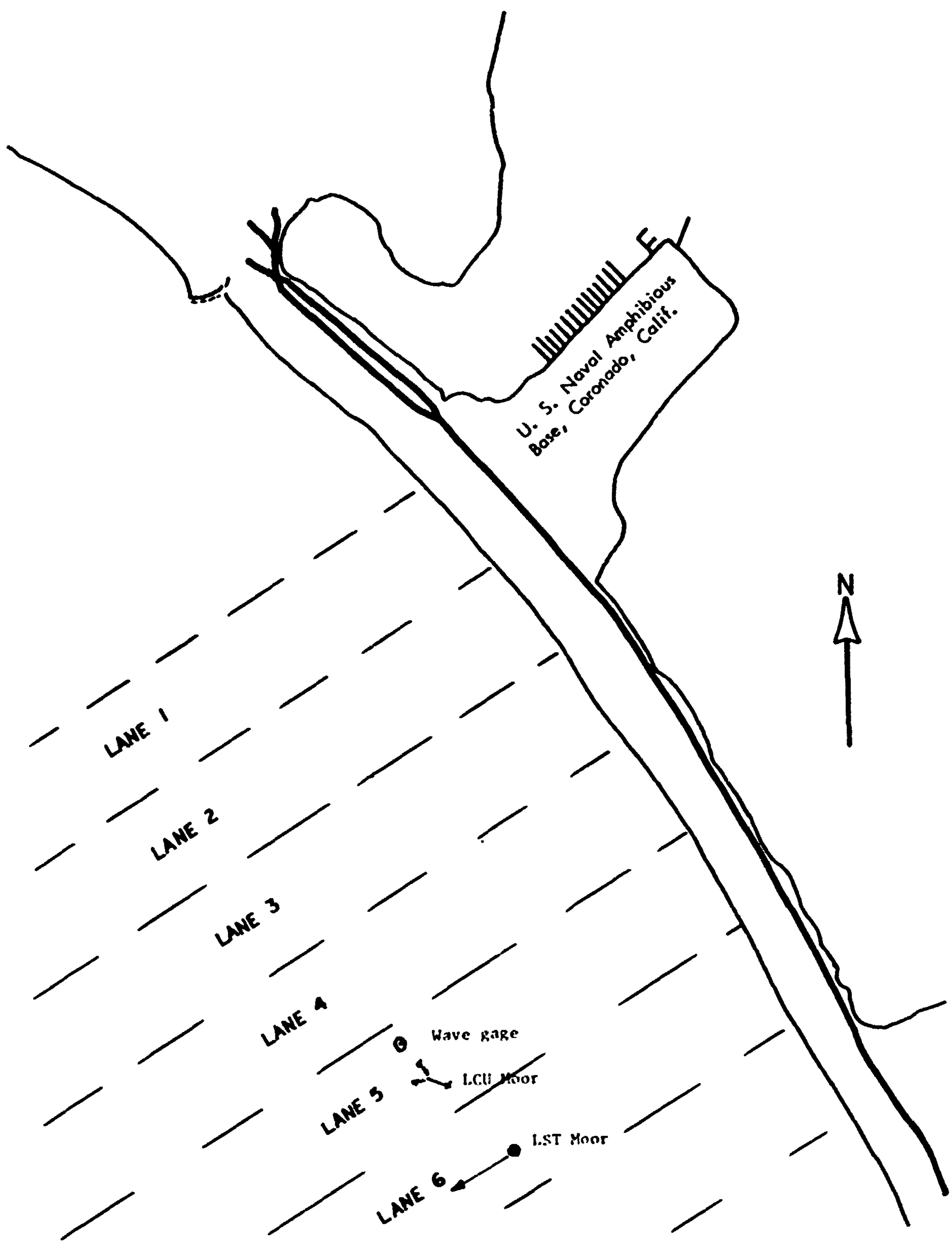


Figure 4. Phase II tests.

Table 1. Naval Planning/Coordinating Personnel
for OSDOC II

Joint Test Director - COL R. A. Cramer, Jr. (DOD Project Manager)
Deputy Joint Test Director - CDR D. G. Ramsey (OP-404F)
Assist. Joint Director and Deputy Director - MAJ P. J. Bistany (AMCPM-CS)
Naval Operational Test Director - CAPT W. J. Aicklen, Jr.
(COMNA 3EACHGRU-TWO)

Evaluation Planning Committee:

CDR D. G. Ramsey (OP-404F) Chairman
G. W. Lynn, Jr. (NAVMAT 047A) Alternate Chairman
M. E. Essoglou (NAVFAC 031A) Chief Technical Evaluator
C. Emberger (NAVSUP 0631F)
G. Quackenbush (MSC M32)
CDR A. McPherson (NAVMAT 0342)

Test Objectives and Planning Coordinator: T. E. Mansfield (NSRDC)

Lead Naval Laboratory: Naval Civil Engineering Laboratory

Operation Coordinator/Shuttle System - R. C. Towne
Crane/Spreader Bar - J. J. Traffalis
Wave/Current - D. B. Jones, S. J. Oppedisano
Barge Motions/Accelerations - D. A. Davis
Container Cell - B. R. Karrh
Shuttle System, Ship - W. G. Hatch
Shuttle System, Beach - R. A. Bliss

Table 2. Safety/Test Evaluators

Engineering Test - Contact Officer - MAJ C. R. Gruning

Senior Safety Officer - CAPT Keonigsberger

<u>COMPHIBOPSUPPAC</u>

Test Evaluator - LCDR W. G. Young
Safety Officer - CWO-2 S. E. Watson

<u>COMPHIBPAC</u>

Safety Officer - CDR Anderson, CO LST-1191
Test Evaluator - LT Hallman

<u>NBG-1, ACB-1</u>

Test Evaluator - LT Barron
Safety Officer - LT Wells

Radio Communications - LCDR W. G. Young

NCEL Evaluators

Coordinator/Shuttle System	- R. C. Towne W. G. Hatch R. A. Bliss
Crane/Spreader Bar	- J. J. Traffalis
Wave/Current	- D. B. Jones S. J. Oppedisano
Barge Motion	- D. A. Davis H. S. Zwibel
Container Cell	- B. R. Karrh

OSDOC II TEST OBJECTIVES

OBJECTIVES AND SUBOBJECTIVES: The following objectives and subobjectives were agreed upon jointly by Army and Navy conferees at a working conference at Fort Eustis, Virginia, 10-11 January 1972. The parenthetical indication at the end of each objective indicates which service initially sponsored the objective and has primary interest, but it does not indicate budgetary, equipment, personnel or unit responsibilities since several objectives require joint effort. Separate enclosures to this plan show Army and Navy budget and equipment requirements.

a. Objective 1: Evaluate surface systems for discharging containers from offshore self-sustaining and/or non-self-sustaining containerships. (Army/Navy)

(1) Subobjective 1.1: Shipboard Crane Test. Evaluate a mobile crane for lifting containership hatch covers and containers to a central lift area and providing an alternate means of off-loading the containers to lighters alongside. (Army/Navy)

(2) Subobjective 1.2: Floating Crane Test (Shipyard YD-225 Type). Evaluate a barge-mounted crane for unloading containers from a non-self-sustaining containership. Evaluate the concept of the floating barge operation and not necessarily the optimum unloading rate or operation of the crane itself. (Army/Navy)

(3) Subobjective 1.4: Seatrain Test. Evaluate the concept of unloading a non-self-sustaining containership with a crane mounted on a large hull located alongside the containership. (Army/Navy)

(4) Subobjective 1.5: Offshore DeLong Platform Test. Evaluate the concept of unloading a non-self-sustaining containership with a crane mounted on an offshore DeLong platform (floating and/or jacked up). (Army)

b. Objective 2: Evaluate selected items of currently available lighterage in the role of container lighter. (Army/Navy)

(1) Subobjective 2.1: Landing Craft Evaluation. Evaluate the capabilities of landing craft as container lighters and the interactions of the container/crane and landing craft/beach operation. (Army/Navy)

(2) Subobjective 2.2: Causeway Ferry Evaluation. Evaluate the capabilities of the causeway shuttle system and interactions of the container/crane and truck/causeway systems. Evaluate the causeway ferry/beach interface operation. (Navy)

ENCLOSURE (1)

(2) Subobjective 2.3: BC Barge Evaluation. Evaluate the capabilities of the BC barge as a container lighter. (Army)

c. Objective 3: Evaluate currently available materials handling equipment in transferring loaded containers from lighters to shore side conveyances. (Army)

(1) Subobjective 3.1: 100-ton Mobile Crane on DeLong Platform (jacked up) at Shore Line Test. Evaluate a 100-ton mobile crane on a jacked up DeLong pier beyond the surf line with a connecting causeway to the beach. (Army)

(2) Subobjective 3.2: 250-ton Mobile Crane at Beach Line Test: Evaluate a 250-ton mobile crane used at the beach line for transferring loaded containers from lighters to shore side conveyances. (Army)

(3) Subobjective 3.3: Aircraft Unloading Truck (A/S32H-12) Test. Evaluate this truck in transferring loaded containers from lighters to shore side cargo dumps. (Navy)

d. Objective 4: Evaluate the platform deck concept of stowing and discharging non-containerized equipment in containership holds and on deck. (Army/Navy)

(1) Subobjective 4.1: Evaluate methods of stowing non-containerized equipment in containership holds and on decks utilizing the platform deck concept. (Army/Navy)

(2) Subobjective 4.2: Evaluate methods of discharging non-containerized equipment from containership holds and decks utilizing the platform deck concept. (Army/Navy)

e. Objective 5: Evaluate the feasibility of underway replenishment between a commercial non-self-sustaining containership and a Navy UNREP ship with the ships underway. (Navy)

(1) Subobjective 5.1: Evaluate extracting 8' x 8' x 20' containers from containership cells and returning them to the cells with CH-54 and CH-47 helicopters. (Army/Navy)

(2) Subobjective 5.2: Evaluate transferring containers from containership to UNREP ship with CH-54 and CH-47 helicopters. (Navy)

(3) Subobjective 5.3: Evaluate container flats (gondolas) in conjunction with existing helicopter lift capability (UH-46) by removing four pallets (6,000 lb. gross weight) from the gondola while in position in the ships cell and while positioned on the deck of the containership. (Navy)

(4) Subobjective 5.4: Determine the feasibility and effectiveness of using a containership to replenish an UNREP ship using existing Navy helicopter lift and equipment. (Navy)

(5) Subobjective 5.5: Evaluate container slinging techniques, auxiliary equipment, and helicopter hookup methods for the containership and the UNREP ship. (Army/Navy)

(6) Subobjective 5.6: Evaluate unstuffing and strike down procedures aboard the UNREP ship; containers vis-a-vis gondolas and TRICON containers. (Navy)

(7) Subobjective 5.7: Evaluate external flight characteristics of containers and determine maximum flight envelopes. (Army/Navy)

(8) Subobjective 5.8: Evaluate the effect of ship motion and weather on UNREP operations. (Navy)

f. Objective 6: Evaluate simultaneous helicopter and over-side off-loading operations from the containership. (Navy)

g. Objective 7: Evaluate container hookup and lifting devices in containership off-loading operations. (Army/Navy)

h. Objective 8: Evaluate the effect of off-center center of gravity in the container on containership off-loading equipment and operations. (Army/Navy)

i. Objective 9: Evaluate tasks and personnel performance for containership deck crew cargo and line handling functions. (Army/Navy)

j. Objective 10: Evaluate the effects of sea state, current, surf, relative motion, beach gradient, and beach conditions during discharge operations. (Army/Navy)

k. Objective 11: Determine crash and fire-fighting support required for OSDOC operations. (Navy)

l. Objective 12: Evaluate selected vehicles and equipment for container transport and handling. (Army/Marine)

(1) Subobjective 12.1: Evaluate hauling containers by M-123, 10-ton tractors with M-127 trailers using Marine Corps drivers and motor transport supervisors/observers. (Marine)

(2) Subobjective 12.2: Evaluate selected trucks, materials handling equipment, drivers/operators, and supervisors/observers handling TRICON containers in the beach area. (Marine)

(3) Subobjective 12.3: Evaluate the rear self-loader/unloader test rig. (Army)

(4) Subobjective 12.4: Evaluate the modified M-127 stake and platform trailer. (Army)

m. Objective 13: Evaluate selected equipment and shore party personnel in beach preparation and control functions during container movement across the beach. (Army/Navy/Marine)

n. Objective 14: Evaluate use of CH-53 medium helicopters with pilots, crews, and helicopter controllers to off-load containers weighted to CH-53 lift capabilities. (Navy/Marine)

o. Objective 15: Evaluate a container "hopper" in positioning containers on trailers during the off-loading of containers from the containership to causeway ferry/barge. (Marine/Navy)

p. Objective 16: Evaluate the LVTR-5 amphibian tractor recovery vehicle and the VTR-51 tank recovery vehicle with drivers, crews, and supervisors/observers for recovery of disabled container tractor trailers in the beach area. (Marine/Army)

q. Objective 17: Evaluate the effectiveness of command, control, and communications operations. (Army/Navy/Marine)

r. Objective 18: Determine safety procedures during evaluation of all other objectives. (Army/Navy/Marine)

s. Objective 19: Evaluate the explosive embedment anchor for use in mooring the containership off shore (anchor developed as part of DA Project/task (D66471D64101)). (Army)

CONTAINER OFF-LOADING HARBOR AND SEA OPERATIONS

First Lift

a. Use spreader with bolt-on guides attached, power taglines secured, and lift bridle attached to auxiliary hook.

b. Lift and transfer four deck loaded 10-ton container to 6 x 15 barge in following sequence: A-1, A-2, A-3 and A-4.

Second Lift

a. Lower spreader to deck of crane barge and remove bolt-on guides and shift lift bridle to main hook (30 minutes).

b. Remove three containers from cell and transfer to deck of LST in following sequence: H-3, place H1 at A-3 area, H-2 at A-2 area and bottom 20-ton container H-3 at A-1 area.

Third Lift

a. Lower spreader to deck of crane barge and replace bolt-on guides (20 minutes). Lift bridle still attached to main hook.

b. As truck/trailers become available, lift and transfer containers to the 6 x 15 barge in the following sequence: (10-ton container at A-2 and A-3 and 20-ton container at A-1 and F-3).

Fourth Lift

a. Lower spreader to deck of crane barge and switch lifting bridle to auxiliary hook.

b. Lift and transfer four deck loaded 10-ton container to 6 x 15 barge in the following sequence: C-1, C-2, and C-3.

Fifth Lift

Lift and transfer three deck loaded 10-ton container to the 6 x 15 barge in the following sequence: F-1, F-2 and F-4.

ENCLOSURE (2)

CONTAINER BACKLOAD - HARBOR OPERATIONS ONLY

a. Use spreader with bolt-on guides removed, power taglines attached and lift bridle attached to main hook.

b. Lift and transfer containers from the 6 x 15 barge in the following sequence: 20-ton container to cell, 10-ton container to cell, 10-ton container to cell, and 20-ton container to F-3.

c. Lower spreader to deck of crane barge, replace bolt-on guides and shift lift bridle to auxiliary hook.

d. Lift and transfer remaining 10-ton container from 6 x 15 barge and position a LST in following sequence: F-4, F-2, F-1, C-3 through C-1, and A-4 through A-1.

OSDOC II ENGINEERING TESTS AT CORONADO -
BARGE MOTION AND LOAD PENDULATION

OBJECTIVE

The objective of the barge motion and load pendulation tests at Coronado, California, is twofold. The primary objective is the measurement of barge roll, pitch and heave and container pendulation during the transfer of containers from the LST 1191 to the causeway ferry. This data, along with measurements of the height and period of waves at the site, currents and wind, will provide detailed documentation of environmental factors critical to the transfer scheme. A secondary goal, the validation of existing ship motion and load pendulation analytical models, will be attempted by conducting a series of controlled tests with the crane barge and LST.

APPROACH

The planned tests are outlined below and appear in descending order of priority.

1. Documentation of Container Transfer - The barge motion and load pendulation will be recorded during container transfer from an LST (mock containership) to a causeway ferry. During the week of 13 March, the transfer concept will be tested in the harbor where the effects of waves and currents are expected to be minimal. The tests will then be repeated at sea during the following week, weather and sea conditions permitting.

The container handling rate for the Coronado tests is estimated to be four containers per hour. Of the total period of 15 minutes to effect one container transfer, a maximum of 5 minutes will be spent with the container suspended from the crane boom. During each transfer at sea, the following measurements and observations will be made:

a. Pendulation of container spreader bar (three components of acceleration).
b. Length of lift line, from point of suspension to spreader bar.
c. Roll and pitch displacement and heave acceleration of the YD-193, 100-ton floating crane (measured at, or near, CG).

ENCLOSURE (3)

d. Height and period of waves at test site.
e. Wave direction and barge heading.
f. Currents at test site.
g. Wind intensity and direction.

Data will be recorded during all container transfers. Barge motion data will be correlated with other observations and measurements by appropriate comments, e. g., container identification, time of day, etc., on tape audio channels.* It should be noted that, as presently planned, there will not be a common time base between the records of barge motion and spreader bar measurements.

Due to the expected short time period for each transfer, statistical processing of the pendulation data will not be attempted. Rather, the motion components of the spreader bar will be processed and presented for study as time histories.

A typical test sequence will proceed as follows:

a. Before each transfer, record the time of day, ship heading and identification of container (recorded on specially prepared data sheets by an observer aboard the LST).

b. Start barge motion and pendulation recorders. Person assigned to operate the barge motion recorder will radio (via portable transmitter) to a technician in the shore based shack when to begin recording load pendulation.

c. Continue to record until container has been placed on causeway ferry. Stop ship motion recorder and radio stop order to technician in shack.

d. Repeat sequence until all containers have been transferred to causeway ferry.

2. Record Barge Motion with LST in Place - This test will take place at sea during the second week of the exercise. Present plans call for obtaining the data during a lull in the container transfer operations, e. g., when the ferry is in transit to or from the beach discharge area. The purpose of the test is to measure the barge motion and wave properties, for a period not less than 20 minutes in duration, for subsequent comparison with analytical predictions. An attempt will be made to record the barge motions with the barge positioned in both the lee and o. the seaward side of the LST. Measured differences in motion for

*All containers used in the tests will be clearly identifiable both at the transfer site and at shore observation stations.

these two cases will provide investigators with insight into the effects of hydrodynamic interaction between the two hulls.

All barge motion and wave data will be reduced to power density spectra. In order for meaningful correlation to be made between these data, the separate recorders for barge motion (aboard the crane barge) and wave height and period (in the shore based instrumentation shack) should be operated during the same time period. However, because of the statistical procedures to be used in analyzing the data, a common time base will not be required.

3. Record Barge Motion with LST Removed - At least one test will be conducted wherein the motion of the crane barge will be measured while isolated from the LST. The purposes of this test(s) is to further assess the effects of hull interference and to collect data under test conditions more amenable to prediction by the existing ship motion analytical model. This test(s) is tentatively planned to take place after completion of the container transfer phase of the exercise. The test procedure is similar to that described for the preceding series of tests.

4. Load Pendulation Tests - Prior to completing the container transfer at sea, one unrestrained, 10-ton container will be repeatedly raised and lowered at a constant line rate (minimum of 10 lift cycles). After each lift cycle, the container will be brought to rest (with either hand held or power taglines) on the deck of the causeway ferry. The purpose of this experiment is to obtain load pendulation data which can be compared with analytical predictions.

Wave properties, barge motions, container pendulation, and lifting line length will be recorded throughout this test. If all planned lift cycles are completed in less than 20 minutes, the wave and barge motion data will continue to be recorded until 20 minutes has elapsed. Barge motion and wave data will be subsequently reduced and analyzed in spectral form

The load pendulation test has been assigned the lowest order of priority. This test will take place only if, at the time scheduled for its execution, it is deemed safe to operate the crane without pendulation control.

OSDOC II PERSONNEL

Name	Activity	Autovon/ Commercial
CAPT W.J. Aicklen, Jr.	CO, Navy Operation Test Director, NBG-2, Amphibious Base, Norfolk, Va.	680-7715
Mr. R.D. Rogers	CDCTA, For Eustis, Virginia	555-1720-2982
COL R.A. Cramer, Jr.	AMCPM-CS (Joint Test Director OSDOC II), Washington, D. C.	225-3976
CDR P.A. Petzrick	MAT 0342, Washington, D. C.	222-2144
CDR A.A. McPherson	MAT 03426, Washington, D. C.	222-2144
Mr. M.E. Essoglou	NAVFAC, Code 031A, Washington, D. C.	227-6020
CDR D.G. Ramsey	OP-404F (Deputy Joint Test Director) Ch. Navy Planning Comm., Washington, D. C.	227-9635
Mr. G.W. Lynn, Jr.	NAVMAT 047A, Navy Planning Comm. Washington, D. C.	692-7924
Mr. C. Emberger	NAVSUP 0631F, Navy Planning Comm. Washington, D. C.	226-7694
Mr. G. Quackenbush	MSC, M32, Navy Planning Comm. Washington, D. C.	896-9425
Mr. M.R. O'Reagan	SUP 063, Washington, D. C.	227-4562
Dr. P.C. Badgley	Dir., Earth Sciences Div., Code 410 Washington, D. C. (ONR)	222-4120
Miss Evelyn Pruitt	Earth Sciences Div., Code 414 Washington, D. C. (ONR)	222-4025
Mr. T.E. Mansfield	NSRDC, Code 1175, Annapolis, Md.	281-2261
Mr. R.C. Towne	NCEL, Code L55, Port Hueneme, Ca.	898-3300-5416
Mr. J.J. Traffalis	NCEL, Code L55, Port Hueneme, Ca.	898-3300-5791
Mr. D.A. Davis	NCEL, Code L55, Port Hueneme, Ca.	898-3300-4217
Mr. D.B. Jones	NCEL, Code L55, Port Hueneme, Ca.	898-3300-4217
Mr. B.R. Karrh	NCEL, Code L55, Port Hueneme, Ca.	898-3300-4865
Mr. T. Vaughters	Code 250.41, Hunter's Point Naval Shipyard, San Francisco, Ca.	799-2336
Mr. D. Kupperstein	Code 250.41, Hunter's Point Naval Shipyard, San Francisco, Ca.	799-2336

OSDOC II PERSONNEL (Cont)

Name	Activity	Autovon/ Commercial
MAJ C.R. Gruning	COMPHIBPAC, Combat Cargo Officer, Amphibious Base, Coronado, Ca.	958-9309
LT R. Barron	PHIBCB-ONE, Operations Officer, Amphibious Base, Coronado, Ca.	958-9524
CDR Anderson	CO, USS RACINE, LST 1191, San Diego, California	
Mr. H. Schwartz	SUPSHIPBuilders-11, Code 1073, San Diego, Ca.	958-2551
Mr. Bellmer	PWC, San Diego	958-2810
Dr. W.G. McIntire	LSU Coastal Studies Institute Baton Rouge, Louisana	(504) 388-2395
Dr. S.P. Murray	LSU Coastal Studies Institute Baton Rouge, Louisana	(504) 388-2395
Mr. A.M. Woolley	Amphibious Vehicle, MCDEC, Camp Pendleton, Ca.	727-3750-2601
LCDR G.M. Griswold	Head, Oceanographic & Geodetic Branch, Code 3256, PMR, Pt. Mugu, California	898-1750-7989
Mr. R.E. Stevenson	Scientific Liaison Officer, ONR, Scripps Inst. of Oceanography La Jolla, Calif.	(714) 453-2000 X-1276
Mr. G.E. Wachnik	NSRDC, Code OH82, Washington, D. C.	227-1700
LT T.D. Solie	COMPHIBPAC, Coronado	958-9321

Appendix H2

OPERATIONAL EVALUATORS REPORTS
(data sheets removed)

COMMANDER NAVAL BEACH GROUP ONE
AMPHIBIOUS FORCE, U. S. PACIFIC FLEET
U. S. NAVAL AMPHIBIOUS BASE
SAN DIEGO, CALIFORNIA 92155

NBG 1/N3:ga
3960
Ser

4 APR 1972

From: Commander Naval Beach Group ONE
To: Commander Amphibious Force, U. S. Pacific Fleet
Via: Commander Amphibious Operations Support Command, U.S. Pacific Fleet

Subj: Evaluation Report on OSDOC Exercises Conducted 13-23 March 1972 at San Diego, California

Ref: (a) CNO 151438Z DEC 71 (NOTAL)
(b) ADMIN CINCPACFLT 080637Z JAN 72 (NOTAL)
(c) COMPHIBPAC 290159Z JAN 72 (NOTAL)
(d) ADMIN COMPHIBOPSUPPAC 022204Z FEB 72 (NOTAL)
(e) COMNAVBEACHGRU ONE 271855Z MAR 72

Encl: (1) CO USS RACINE ltr 3960 ser 75 of 27 Mar 72 and daily observer reports
(2) COMPHIBOPSUPPAC Daily Observer Reports
(3) PHIBCB 1 Daily Observer Reports
(4) PWC SDIEGO Daily Observer Reports/CO, PWC SDIEGO ltr ser 539 of 30MAR72
(5) 9th MTR BLT, 3rd PLT, B. Co., USMC, Camp Pendleton Observer Reports
(6) Summary of Observers Daily Comments/Problems encountered during Inport Phase
(7) Summary of Observers Daily Comments/Problems encountered during Open Sea Phase
(8) Photographs of the At Sea and Open Sea Phases of the OSDOC Operation

1. Reference (a) requested that CNO be advised as to the feasibility of PACFLT's participation in the Off-shore Discharge of Containership (OSDOC) Evaluation Tests to be conducted in March 1972. Reference (b) approved the use of the desired PACFLT assets on a not-to-interfere basis as noted in reference (a).

2. In compliance with reference (c) COMNAVBEACHGRU ONE was designated OCE for the OSDOC evaluation test by reference (d). Reference (c) directed the OCE to consolidate the test evaluation result and forward the report to COMPHIBPAC.

3. In order to prepare for OSDOC II, which is to be held in OCT 72 at Fort Story, Virginia, COMPHIBPAC was tasked with providing NCEL with the necessary fleet support for conducting engineer tests and evaluation of the concept for the off-loading/discharge of containers from a non-self-sustaining containership i.e., no permanent crane aboard. The tests were scheduled to be conducted during the period 13-24 March 1972.

4. The USS RACINE, (LST 1191) was designated to perform the functions of the non-self-sustaining containership. The Public Works Center, San Diego provided and operated the 100 Ton Floating Crane. PHIBCB 1 was assigned the responsibility of providing 2 four section causeway ferries, a causeway loading platform, four standard warping tugs, an eight section causeway pier and the men necessary to operate these assets and conduct the cargo shuttle operations. The 9th Motor Battalion, 3rd Platoon, B Company, USMC, from Camp Pendleton provided the truck/trailers and drivers. Prior to the start of the exercise a detachment of men from the Naval Mobil Construction Battalion FIVE installed a 100 ft. by 100 ft. aluminum matting (AM-2) pad on the beach for a staging area. This staging area was enlarged by the installation of an additional 100 ft. by 100 ft. pad consisting of a test material known as "On-Fast." This material was applied by NCEL. Each participating unit had designated test evaluators and safety observers on site throughout the exercise.

5. The OSDOC engineering tests were conducted in two phases: first phase in San Diego Bay during the week 13-17 March 1972 with ship moored to buoys in the inner harbor and second phase in the open sea off the Silver Strand, Coronado, California during 20-24 March 1972 with the ship moored to a pre-set buoy by the stern and anchored forward.

6. Enclosures (1) through (5) contain the designated commands daily comments as prepared by their respective observers. Enclosure (1) also contains the post exercise report prepared by the Commanding Officer, USS RACINE (LST 1191). Summaries of the comments regarding problem areas with recommendations to correct the difficulties encountered during the Inport and Open Sea Phases of the exercise are stated in enclosures (6) and (7) respectively. Enclosure (8) contains a series of photographs taken during both phases of the operation.

7. The preliminary view of the OSDOC engineering evaluation test indicates the concept perse is feasible, however, some major problems were encountered that would limit a successful operation of this magnitude due to the type of assets used and the attendent requirement for acceptable surf, wind and sea state conditions.

8. Only the major problems, from an operational point of view, will be discussed in the basic letter. Other problem areas are noted in enclosures (1) through (7). The inport phase was, in general, considered successful. The major operational problems encountered during the open sea phase of the operation off the Silver Strand are as noted below:

a. Constant surging of the PWC 100 Ton Floating Crane alongside the LST. This was eventually reduced to acceptable limits by modification of the mooring arrangement for securing the crane to the LST.

b. The camels used between ship and crane were not of sufficient width to properly separate the crane and the LST. As a result, considerable damage was inflicted to the ship's hull around the counter above the waterline.

c. The sea state ranged from 6 to 8 ft. during the operation and should not generally exceed sea state of 3 ft. with a maximum of 4 ft. for successful off loading operations.

d. The causeway ferry was unable to marry to the end of the eight section causeway pier due to surf/swells exceeding 7 ft. Surf/swell conditions at the end of the pier should not, in general, exceed 4 ft. for successful operations.

e. The use of the present assets i.e.; causeway ferry with standard warping tugs, causeway barge platform, 100 ton floating crane, relatively small staging on the beach area etc., as a system to off-load and discharge the cargo over the beach is considered to be undesireable and of major concern for use in operational environment at an objective area mainly for three reasons noted below:

(1) Acceptable surf, wind and sea conditions required are not expected to generally prevail at the objective area.

(2) Present limited Amphibious shipping would preclude use of assets of this magnitude at objective area in early phase of assault.

(3) The staging area constructed on the beach for this operation consisted of 20,000 sq. ft. of AM-2 aluminum matting and "On-Fast" material located approximately 100 ft. inboard of the shore line and connected to the causeway ferry/pier by Mo-Mat for movement and off load of containerized cargo from the truck/trailers. Although this arrangement proved satisfactory for this test, the unloading of 1000 containers from a containership would present astronomical problems in providing proper staging and unloading areas during an Amphibious Assault. The beach terrain and gradient along the Silver Strand were practically ideal. The concept of unloading the containers on the beach or moving the loaded containers in-land in support of the forward area was not a test objective but must be given appropriate consideration in the development of the OSDOC concept. Truck/trailers with 10 ton/20 ton loaded containers cannot move in the sand without some type of matting for a road surface.

9. The Inport Phase went relatively smooth due to the calm seas and wind conditions encountered. On 16 March 1972 a total of eight 10 ton containers were off-loaded and placed on the truck/trailers aboard 2-four section causeway ferries and transferred to the concrete ramps at the Naval Amphibious Base, Coronado for off-loading. The second day 2-three section causeway ferries (without the standard causeway beach end) were used to test capability of marrying the barge ferry to a pre-set causeway pier at the NAB CORO ramp. Seven 10 ton containers and one 20 ton container were shuttled ashore. During the afternoon, all containers were ferried back to the ship and backloaded with the exception of the one 20 ton container.

10. During the At Sea Phase of the evaluation test conducted during 21-23 March 1972, operations were delayed due to the difficulties in securing the YD Crane alongside. Once the crane was alongside there was considerable surging and parting of lines on both the 6 x 15 pontoon can causeway platform and crane. This surging of the crane caused a cancellation of the operation for that first day. PHIBCB 1 personnel prepared a sketch for a mooring and fendering plan for all assets to minimize the surging. This was discussed with representatives of PWC and then submitted to the Commanding Officer, USS RACINE (LST 1191), for his approval. On the following day, except for the initial delay in mooring the crane alongside the LST as recommended, operations proceeded on schedule and eight containers were off-loaded and shuttled to the beach in 2-four section causeway ferries utilizing two warping tugs per ferry.

11. On 23 March 1972 sea state conditions had deteriorated and difficulty was encountered mooring the crane to the ship. Eventually off-loading operations were able to proceed. Causeway ferries made up of three causeway sections were scheduled to shuttle to the beach and marry to the end of a pre-set eight section causeway pier. However, due to sea state conditions only three containers were off-loaded prior to cancelling the operation. The one causeway ferry, with the truck/trailers loaded with containers, attempted to marry to the end of the causeway pier. However, after considerable effort this part of the test was also cancelled due to the surf conditions and the 6 to 8 ft. swells at the end of the pier.

12. This report has not attempted to evaluate the engineering aspects of the exercise but has been limited to an operational discussion of the problems encountered using existing PACFLT assets.

13. In summary, the OSDOC tests, using existing Navy assets, cannot be considered operationally acceptable because of the limitations discussed herein and in reference (e) (COMNAVBEACHGRU ONE's preliminary report). These tests did serve to highlight the need for development of a new system. Some ideas/considerations for the development of such a system are:

a. The system should include a containerized ship with the crane as an integral part of the ship.

b. As limited shipping available will probably not be able to accommodate a pontoon causeway/warping tug - barge ferry system, the aim of the development program should be to include as an integral part of the system the containerized ship, crane, and the conveyance to move the containers ashore. Possibly self-propelled barges which could be sideloaded on the containership could function as the conveyance system. The necessary hinge rails to accommodate these barges could be designed and constructed as a permanent part of the ship's hull structure. These self propelled barges would be designed specifically for the containers and probably would not have to be as massive as the present pontoon causeway sections.

c. The system should provide for containers of a size and configuration that are operationally acceptable/compatible with conditions/customers ashore. The containers should be designed to fit on existing vehicles and/or vehicles programmed for development which can carry the loaded containers through sand and other operational environments without the assistance of some type "matting" surface.

d. The system should provide for an alternate means of moving containers ashore if the Barge Ferry cannot make it through the surf zone or into the beach because of the existence of sand bars, reefs or poor beach gradient. Current landing craft, particularly the LCU, could handle the containers provided that a properly designed wheel-base carriage, could be expeditiously and securely attached to the container after it has been removed from the container cell and prior to loading the container into the LCU. After the LCU has beached, the container could be pulled ashore and positioned in the staging area.

C. Koenigsberger

C. KOENIGSBERGER

Copy to:
COMNAVBEACHGRU TWO
CO PHIBCB 1

FF8-3:35:mnh
3960
Ser

FIRST ENDORSEMENT on COMNAVBEACHGRU ONE ltr NBG 1/N3:ga 3960 ser 167 of 4 APR 1972

From: Commander Amphibious Operations Support Command, U. S. Pacific Fleet
To: Commander Amphibious Force, U. S. Pacific Fleet

Subj: Evaluation Report on OSDOC Exercises Conducted 13-23 March 1972 at San Diego, California

1. Forwarded.

JOHN F. [illegible], JR.

Copy to:
COMNAVBEACHGRU ONE
COMNAVBEACHGRU TWO
CO PHIBCB ONE

FF4/13:30:jeb
3960
Ser: 30-

SECOND ENDORSEMENT on COMNAVBEACHGRU ONE ltr NBG 1/N3:ga ser 167 of 4 April 1972

From: Commander Amphibious Force, U. S. Pacific Fleet
To: Commanding Officer, Naval Civil Engineering Laboratory, Port Hueneme

Subj: Evaluation Report on OSDOC II Exercises conducted 13-23 March 1972 at San Diego, California

1. Readdressed and forwarded. COMPHIBPAC concurs with the comments, conclusions and recommendations contained in the report.

2. Considerable concern must be expressed concerning the operational aspects of the OSDOC concept. The test environment during the at-sea phase was characterized by sea and surf conditions no greater than those normally encountered during an amphibious operation but proved prohibitive for OSDOC offload operations. Accordingly, it is considered infeasible to conduct offloading by barge crane and causeway ferry/marriage operations in a sea state above four (4) foot maximum.

3. It is further concluded that reliance upon the delivery of containers ashore to the Landing Force in an AOA by barge crane/causeway ferry operations is not realistic in view of the magnitude of daily requirements of the Landing Force ashore. The quantity of the barge/crane, causeway and motor transport assets required to support the concept as well as the prohibitive sea and surf conditions which may prevail render this technique suspect until further evaluation is conducted and other alternatives are examined.

Nels C. Johnson

NELS C. JOHNSON

Copy to:
CNO (complete)
CHNAVMAT (complete)
CINCPACFLT (complete)
COMPHIBOPSUPPAC
COMNAVBEACHGRU ONE
COMNAVBEACHGRU TWO
CO PHIBCB ONE
COMPHIBLANT (complete)

7

OFFICIAL FILE COPY

USS RACINE (LST-1191)
FLEET POST OFFICE
SAN FRANCISCO, CALIFORNIA 96601

LST1191:50:pjd-
3960
Ser 75
27 MAR 1972

From: Commanding Officer, USS RACINE (LST-1191)
To: Commander Naval Beach Group ONE, Naval Amphibious Base, Coronado, San Diego, California 92155

Subj: Evaluation Report of OSDOC II, conducted 13 March-23 March 1972 at San Diego, California

Ref: (a) OSDOC II Operational Schedule of March 1972, published by NCEL Port Hueneme, California

Encl: (1) Evaluation Report

1. Reference (a) contains detailed information for the conduct of OSDOC II.

2. Subject evaluation report, submitted as enclosure (1) in support of reference (a), is germane only to problems encountered aboard ship.

D W Anderson
D. W. ANDERSON

Copy to:
ACU-1

Enclosure (1)

EVALUATION REPORT OF SHIPBOARD OBSERVATIONS
OSDOC II ENGINEERING TRIALS CONDUCTED 13-24 MAR 1972

The following are observations by USS RACINE (LST 1191) personnel concerning the OSDOC II experiment:

Phase one of the experiment was completed in San Diego harbor in a smooth and efficient manner with the exception that the vacuum tie downs were not used due to electrical difficulties with the compressor.

During phase two, conducted off Coronado Roads, the sea swells varied between one and three feet rising to a six foot maximum and wind speeds varied between one and thirteen knots.

The vacuum ties were not used at any time during phase two. The positions of the crane barge and the platform had been changed since the inception of the project, thereby eliminating the possibilities of using the vacuum ties.

During phase two, it became apparent that even the slightest wave action would cause the crane barge to surge wildly, making it increasingly difficult to be securely moored. In addition, swells of over five feet created so much surge that it was unsafe to moor the crane to the ship. The off loading of containers, however, was accomplished smoothly under the existing surge conditions and did not seem to be slowed down appreciably by the surge of the crane barge.

On day one of phase two, the crane barge arrived at the ship and attempted to moor without the proper mooring aids in place on its deck or the proper mooring lines and wires available. The crane barge was equipped only with five inch polyethylene lines, all of which parted when a moor was attempted. Thus, day one ended without a successful moor between crane barge and ship.

On day two of phase two the crane barge attempted to use eight inch mooring lines, but only provided two lines. The ship provided three additional lines. The barge was able to make a marginally satisfactory moor to the ship using six and eight inch lines plus archors fore and aft. Eight containers, including three in the cell, were off loaded.

On day three of phase two, the moor of day two was utilized once more. It again proved to be marginally satisfactory at best. In swells of three to six feet, most of the ship's fenders were torn off. The ship began to suffer extensive hull damage as a result of the crane barge's surging and the project was terminated. The ship lost 26 rubber mooring fenders; four eight inch nylon mooring lines were damaged beyond repair. Three of the remaining six containers were successfully off loaded.

CONCLUSIONS

The OSDOC II evaluation pointed out that the crane barge is an impractical means to off load a containership. A crane barge of the nature used is totally unsatisfactory for the OSDOC trail or its end result due to the uncontrollable surge.

The incompatibility between barge and ship would be inherent in any such operation due to vast difference in size between the two.

This operation might have been more successful if it had been thoroughly planned beforehand. The limiting factor throughout was the mooring of the crane barge to the ship which should have been carefully taken into account. The inadequacy of the vacuum ties and the failure to provide sufficient and correct material to moor the crane and to fend it off from the ship requires further study.

A plan for mooring the crane barge to the ship, developed by ACB-ONE was not explained to crane barge personnel. It was imperative for them to be knowledgeable of mooring plans prior to arrival at the ship.

The platform ship noticed no difficulty during the actual loading and unloading of containers on deck and into the cell. The ship could accommodate a maximum of 18 containers loaded in this manner and maintain sufficient working space. The containers loaded in the cell proved to be easier to load and off load than those on deck due to excellent spreader bar guides positioned at the top of the cell. The crane was able to reach all working areas of the ship effectively. The only problem of clearance occurred when the crane was loading on the pontoon platform, when the distance between the crane cab and the ship approximated two to three feet.

Surging of the crane barge seemed to have no effect on the operator's ability to successfully position the spreader bar with or without a load, nor did it effect the riggers' ability to control the load using 15 ton block. The 100 ton block, however, became unmanageable in swells of over 4 feet.

RECOMMENDATIONS

The existing type of crane barge used should be discarded as a factor in the trial. For practical results, the crane to be used should be mounted on a stabilized platform, preferably a ship.

A crane barge of this nature, if necessarily used, should be provided with fenders similar to those found on most tug boats. These rubber and manila rope constructed fenders should be made to extend over the entire side which is to be moored to the ship and well around both corners of the barge. These should then be supplemented with a combination of the mooring fenders which the ship provided and log camels of sufficient size to be effective. One 400 foot and three 200 foot lengths of spring lay wire should be used vice any type of mooring lines.

Civilian personnel on the crane barge should be thoroughly briefed on mooring plans and safety precautions prior to arrival at the ship.

The idea of using vacuum ties in this type of operation should be completely discarded or re-evaluated.

Taglines used to handle containers should always be cleat tended. Sufficient cleats should be provided on the platform ship, the crane barge, and the pontoon in order to tend these lines.

OPERATIONS SUPPORT, PACIFIC FLEET

15 March 1972

1. The first days evolution was conducted in a very smooth manner. No major problems were encountered.
2. The 6x15 loading platform appeared to be too small at the start. The hyster requires 5 sections when perpendicular to the platform axis. After the initial jockeying of the first container there was adequate room. The addition of 3 more sections would definitely be advantageous for work space and stability.
3. The motor unit for the power taglines was inadequate to keep a strain on the lines. This unit was disconnected after the first four containers had been off loaded.
4. The vacuum pump for the suction pad was inoperative until 1130. Ships company repaired the unit. Power overload kept kicking unit off. Vacuum pads will be installed this afternoon.
5. The locking device on the spreader bar sheared but did not cause any problem. Pin was replaced by ships company.
6. The first marriage of the causeway section with the 6x15 was completed in 1.5 minutes. The second marriage was conducted with the hyster on the 6x15 section. By moving it and redistributing the weight the sections were leveled and quickly married.
7. A total of 8 containers were scheduled to be off loaded, 7 10-ton and 1 20-ton. Eight (8) 10-ton containers were off loaded. No explanation was given as to reason for change. It did not affect any of the operation.
8. One complete cycle lift required a total of 9 minutes and 06 seconds. From main deck to 6x15 platform 4 minutes and 20 seconds. From 6x15 platform to secured on trailer required 5 minutes and 50 seconds. The difference in times is due to timing of different lifts.
9. All in all I would consider the first days test highly satisfactory with no significant problem areas.

16 March 1972

1. The OSDOC II tests scheduled for Thursday, 16 March were completed ahead of schedule with only minor difficulties.
2. Seven vice six containers were off loaded via a 3-section causeway train in two trips. The train was off loaded on a 2-section causeway moored to the concrete ramp.
3. The first train contained the 20-ton container on the bow section. There were no problems in the joining of the two sections at the concrete ramp.

4. There were, however, a number of problems during today's phase that bear mentioning:

a. The vacuum pump used on the suction pads was burned up prior to 0745 this mooring. Apparently what happened was that the pump was turned on by someone on the ship either during the evening or early morning hours and the motor and wiring overheated and burned up. At 0730 the fantail watch extinguished the motor unit with PKP.

b. The power taglines again did not appear to work satisfactorily. The unit was worked on yesterday but the motor is too small for the loads being handled. Headhog line was adequate for smooth water operations but may become a problem at sea.

c. The 20-ton container was lifted using the big hook and set on the 6x15 platform with no problems. When the hysters inserted the forks they were in all except the last 12". When lifting the back, the wheels were barely touching the deck. The hyster was able to lift the container under the conditions, but would have been unsafe under sea conditions. The front wheels dished the causeway plate that had not been strengthened. The actual tire track was imbedded in the plates.

d. The trailer with the 20-ton container was moved with the wheels on the strengthened plates with little or no problems. There was a little bound in the middle of the trailer. With the weight the sections, where connected, were buckled about 18 inches as the trailer crossed. As the tractor left the causeway at the ramp at about a 45° angle the positive stop of the fifth wheel was hit. It is not known if this is an actual limiting or positive stop which could have caused problems. On a 10-ton load we ran a crush test and there did not seem to be any excessive pressure exerted.

5. Due to the problem with the 20-ton lift there will be no 20-ton lifts attempted next week at sea with the hyster.

6. Present complete causeway ferry train cycle from ship-t-ramp-to-ship requires 60 - 70 minutes.

7. All backload was completed during the afternnon Thursday vice Friday as scheduled. A critique will be held Friday AM vice 1500.

8. The performance of the Seabee unit has been extremely noteworthy. Every man seems to understand the entire program and has been well briefed. There has not been a raised voice or a single man yelling orders or people running to and fro. Causeway trains have been married to the 6x15 platform and the stub pier in an average of 2 minutes.

21 March 1972

1. The tests for Tuesday, 21 March, were called off at 1120 due to difficulties in securing the YD to the ship. The problem was in the proper use of the mooring lines, i. e., 4-inch polypropylene, nylon braided, 3-in-1 power braid, and manila mixed. Excessive slack caused surging and parting of lines. The 6-10 fenders between the ship and

the crane all parted at one time or another. All had been secured with line. After the metal to metal rubbing of crane and ship caused quite a bit of mi-or dishing of ship plates and tearing of port quarter, the fenders weie secured with cables. While the problem existed between the ship and crane a similar situation was occurring between the 6x15 and the crane. All lines parted at one time or another due to ships difficulties and deteriorated line. By the use of line provided by ACB-ONE this problem was alleviated. While causeway ferries were married to 6x15 platform the working condition caused one section to have two cans become loose but not adrift.

2. There was little problem in running the causeway trains to the beach either empty at low tide or with four tractors and trailers. The TD-25 bulldozer was used to push the causeway off and hooked on with winch to pull causeway in to give a completely dry ramp. AM-2 matting was used and no problems encountered.

3. The down chains for the trailers were not adequate. There was no means of tensioning the chains after attachment. The use of "Peck and Hale" hold down gripe should be used. It is not believed that these will be available during the remainder of the tests.

4. The inoperative valve in the power tagline system was repaired and while not tested appeared to eliminate some swing.

5. The vacuum pump was repaired and available but not used as the suction pads are incompatible with this type of crane.

6. The same tests scheduled for today will be rescheduled for tomorrow with ACB-ONE and Mr. Rainey of PWC drawing up an adequate mooring plan. ACB-ONE will provide 8 inch 3-in-1 power braid lines to ship. PWC will have a large camel between crane and ship which will protect ship sides as well as provide additional clearance for the swing of the cob as it approaches the ship.

7. While frustrating at times, there was a great deal learned that should cause tomorrow's plans to go smoothly. All of the old lines were parted today so tomorrow we will have new and adequate line, hopefully.

8. Sea and weather conditions were ideal and are anticipated to be the same tomorrow.

23 March 1972

1. The tests scheduled for Wednesday, 22 March 1972, were conducted satisfactorily. Eight containers were off loaded. Five from the deck and three containers in the cell.

2. Steering the barge to the ship continued to be a small problem. It seems as though no one on the ship is aware of how to get all the slack out of the lines. They were obviously either afraid or reluctant to place a strain on the 8-inch lines being used. ACB ONE provided the ship with a copy of the suggested mooring plans which the ship indicated they would use. Warrant Officer Troino of ACB ONE finally had to be brought in from the causeway train and direct the placing and tensioning of the lines on the ship. Once this small flap was completed the crane rode satisfactorily and all evolutions were very smooth.

3. During the marrying of the second causeway train to the 6x15 platform in the afternoon there was considerable wind and cho᷊ ·y seas. While having a lot of effect on maneuvering there was little difficulty experienced.

4. The one injury of the day occurred to the PWC foreman on the crane. He and all others in the area had been advised that one of the 8 inch lines was going to jump a dleat and to stand clear. While checking other lines he moved into the area as the line did in fact jump the cleat. He received a broken tibia and will be hospitalized approximately 6 weeks.

5. Today's schedule consists of removing the remaining 7 containers via the ferry and causeway marriage system. There will be one 20-ton container remaining on board which will be off loaded at the pier.

WATERFRONT OFFICER PHIBCB 1

15 March 1972

Problem: Marriage bridles were not of sufficient length.

Action Taken: Connected bridle eyes to first cleat vice second cleat inboard of causeway end. New bridles of proper length have been issued to Beach Bravo.

Problem: Forklift had problems inserting forks into container openings due to small openings and forks were out of line.

Recommendation: Enlarge holes in container and re-adjust fork tongs.

Problem: Containers would not set level on 6x15 barge because of angles and protruding bolts which also would cause damage to the container.

Action Taken: Layed three pieces of plywood on 6x15 barge between angles.

16 March 1972

Problem: As mentioned in report submitted for the phase held on 15 March 1972, the forklift blades are too thick causing difficulty in inserting the retracting blades from containers.

Recommendation: Thickness of blades should be planed down.

Problem: When forklift hoisted the 20 ton containers the rear wheels left the platform deck. This could cause serious damage and a safety hazard during operations especially in any type of sea condition other than complete calm waters such as experienced in the closed harbor.

Recommendation: With present forklift no load heavier than 10 tons or maximum 15 tons should be lifted.

Problem: 6x15 platform not wide enough to maneuver forklift with ease.

Recommendation: Platform should be 8x15 or a full 9x15 to sufficient room to maneuver.

21 March 1972

Problem: First and foremost the YD crane was made up to the ship completely wrong, which was the main reason for cancelling the operation for the day without accomplishing a single lift.

Action Taken: Numerous lines were replaced on ship to barge, fenders, and 6x15 platform to crane as they parted due to extensive surging of yard crane. Finally, a head line was led from the forward part of the ship to yard crane but was a 1-inch wire which was completely unsatisfactory.

Recommendation: That the yard crane and 6x15 platform be secured properly as recommended at conference held during afternoon of 21 March 1972.

Problem: There was no camel placed between the ship and yard crane for protection.

Action Taken: Fendering was placed between the ship and yard crane, but insufficient to protect the ship from damage.

Recommendation: Camel be supplied by PWC for placement between ship and yard crane. This camel to be tended by the ship with 5 or 6 inch nylon lines.

Problem: Chafing of securing lines between yard crane and 6x15 platform causing lines to part along with the heavy suring of the crane due to improper securing lines to ship.

Action Taken: Continuously replaced lines as they parted.

Recommendation: As stated in previous problem areas, there is a need for the yard crane to be properly secured to the ship to alleviate the excessive surging of crane.

Problem: Bitts on 6x15 platform broke off causing a grave safety hazard.

Action Taken: Securing lines were wrapped around causeway angle irons.

Recommendation: Additional reinforcement needed when installing bitts to causeway to insure proper strength.

Problem: End cans on two causeways broke loose due to improper assembly, loosened bolts and cracked welds.

Action Taken: Continuous watch placed on section to watch for further damage and to report to Officer in Charge.

Recommendation: Weld "A" plates on facing between each end can. This is a normal requirement by NCEL and adds considerably to the strength.

Problem: One 1-inch chain and pelican hook used in conjunction with 6x15 yard crane securing line parted. This caused a grave safety hazard.

Action Taken: Deleted the chains and pelican hooks using 5-inch nylon line only.

Recommendation: Use 1 1/4-inch wire straps around causeway angle irons and secured into 5-inch nylon line, thereby alleviating the chafing of the lines.

Problem: Unable to cinch up properly on 3/4 inch chain used to secure trucks to causeway sections.

Action Taken: None

Recommendation: Use Peck and Hale grips or aviation grips for faster and more secure method of securing the trucks to causeway.

22 March 1972

Problem: Two additional bitts broke loose from the 6x15 platform.

Action Taken: Rigged wire straps around angle irons for securing lines.

Recommendation: Insure bitts are welded properly and reinforced.

Problem: Two 5-inch nylon securing lines on 6x15 platform parted.

Action Taken: Replaced lines.

Recommendation: PHIBCB 1 should have 6-inch nylon line to use for head and stern lines for an operation of this magnitude. A 1250 has been submitted to Supply for the line.

BEACH BRAVO COMMAND PHIBCB 1

Comment: Unloaded ferry rode up too high on concrete ramp. Difficulty encountered retracting ferry each time.

Recommendation: Slower approach to ramp required when unloaded. A pusher vehicle (TD 15, 25 or forklift) required to assist ferry retraction.

Comment: Forklift had difficulty inserting and retracting forks from slots in container boxes.

Recommendation: Slots in container boxes should be larger.

Comment: Forklift had difficulty maneuvering to insert forks in slots in container boxes because of container angle on platform.

Recommendation: Containers should sit perpendicular to ship on second, third, and fourth cans from inboard side. This should greatly increase maneuverability of forklift.

Comment: The deck of the 6x15 platform distorted as forklift maneuvered resulting in forks becoming unlevel.

Recommendation: Deck of 6x15 loading platform should be re-enforced with additional steel plating to prevent sagging of the deck as forklift maneuvers.

Comment: Difficulty retracting forklift forks from container slots when box is loaded on trailer, due to slight angle of bed to 6x15 deck.

Recommendation: Elevate back end of box by one inch (1/2 sheet of 1 inch plywood) to compensate for slight angle.

Comment: No containers off loaded this day (21 March) due to difficulties encountered in securing PWC crane to ship. Operations secured at 1130 in order to develop a better mooring system.

Comment: Once the PWC crane was properly secured to the LST the remainder of the operation went smoothly.

Comment: The difficulty of beaching the causeway ferry due to tide/beach gradient conditions was overcome by "snaking" the ferry up the beach with the TD-25 dozer.

Comment: Due to heavy surf conditions the 3-section causeway ferry could not marry to the pier after loading the three containers. All assets were told to return to base at 1300.

Recommendation: A 12-section causeway pier be inserted at the strand to prevent end from being in surf zone.

OBSERVATIONS ON OSDOC II ENGINEERING TESTS
(PWC, San Diego)

1. The following observations were made by the operating forces aboard the YD 193 during the at sea container off loading exercise from the LST-1191 to causeway:

a. Fenders should be at least 5 feet in width between the crane barge and ship. This not only would prevent the barge crane from damaging the ship would also allow the crane to swing 360° without the counterweight hitting the side of the ship.

b. If at all possible, in rough water a crane with a "free fall" hook should be used. This would allow the operator to slack off the strong back fast to keep up with the surge, give the operator better control, and prevent the strong back guides from punching holes in the container.

c. The strong back guides should be longer and built out of heavier material. Two should be placed on the operator's side and two on the right end, if you are swinging to the left, and the reverse end if you are swinging to the right to hook on containers.

d. The tagline concept to control the container is an excellent idea but the operator should have better control than was allowed with the air friction that was used in this test. At no time during the use of air control could you tell how much pressure or added line pull was put on the tagline. During one of these tests when released, the increased tension broke one of the sheave blocks. It is recommended a graduated control valve that would give zero pound line pull up to whatever pull is needed to turn the container to be used. There should be at least five known line pull positions to each side. In addition, the which, sheaves, and wire should be heavier for use on this large of a crane.

e. It would help the operator a great deal if the operator's cab was up high so he could alsays see the strong back or the container if possible. This caused no problem while unloading the LST but it could create a major problem if unloading a containership whose sides are 60 feet above eater. While swung over the ship, the operator's can on the YD 193 is only one foot from the side of the ship.

f. There was no difficulty in lifting the 10-ton containers fast enough to clear the other containers before the surge took over but it is recommended that a signalman and four tagline men be used. If only four men are used, it is impossible for the operator to watch all taglines to check if they are fouled and also watch the container to keep the swing out of the load.

g. Added cleats should be provided on this type of operation for use by the tagline handlers. In this exercise all of the existing ones were used to secure the crane to the ship and the causeway to the crane.

h. If a good mechanical tagline is used, the operator should be properly instructed on how to use it and be proficient in its operation before off loading a containership.

i. In using a smooth water crane for rough water, all sheaves should have guards. If two hooks are on the crane and both hooks are to be used one at a time, the main hook should have taglines hooked to the heel of the boom on either side and controlled by an air tugger or electric winch so the crane operator can take up the slack on the tag-line when lowering the hook. Keeping a tension on the line will prevent the hook from singing in a fore and aft motion and the operator can control the side motion with the swing.

j. For the deck operation, nothing smaller than 10 inch nylon should be used. This has a great stretching ability as well as a high breaking strength. On the first day of this operation we used 8 inch polypropylene and polyethylene line which would not absorb the impact on fast surge. The line would stretch and breack.

k. The causeway used to land the containers should be six pontoons wide instead of the five wide used. This would give the forklift operator more room to manuever. All bolt heads should be cut off and flush decked. This would allow the forklift to pickup the container anywhere the crane set it down without the bolt heads interferring with the forks.

2. In our opinion the YD 193 performed the harbor off loading as well as any crane could, both safety-wise and speed-wise. For rough water this type of crane is not the best method of off loading containers but with the proper fender system, good securing lines, and the above suggestions enacted, a containership could be unloaded.

3rd Plt. B Co. 9th MT Bn. and OSDOC II

From 14 March to 24 March 1972 this unit was TAD to Amphibious Force Pacific Fleet at Naval Amphibious Base, Coronado, for engineering evaluation in relation to an Offshore Discharge of Containership (OSDOC) exercise.

The purpose of the exercise was to determine the present military capability and shortcomings for unloading containerized cargo at beach-heads.

The need for such a capability has become apparent in face of the limitited lift capability of the Amphibious Fleet and the conversions of almost all commercial shipping to containerized cargo handling methods and facilities. As these are the vessels which should be conscripted to augment the Fleet, the compatability of military equipment with containers is being evaluated.

The tractor-trailer platoon of B Co. 9 MT was tasked by 1st Motor Transport Bn., its parent unit, to provide eight tractor-trailers with drivers and supervisors for the OSDOC tests at Coronado.

Specifically, the tractor-trailers were used as platforms for carrying cargo containers while being ferried ashore. They moved from the beached ferries over prepared synthetic surfaces to a hardstand on shore, where they were unloaded by mobile crane.

The operation was simple in scope. At sea there were four operational elements:

1. The ship moored 2,000 yards offshore.
2. The barge crane moored alongside the ship.
3. The loading platform with forklift moored alongside the barge crane.
4. The multi-section causeway ferries shuttled ship to shore, docked with loading platform, beached, powered by warping tugs.
5. The tractor-trailers boarded ferries at the beach, move to loading platform, moved to empty ferry, and moved off ferry to beach.

Tractor-trailers were transported from the beach to the ship on multi-section causeway ferries by tugboats. An empty ferry was also transported to the ship and the ferries were linked up end to end with the loading platform moored to the crane barge. Commercially manufactured cargo containers (8'x8'x20', 10 and 20 payloads) were off loaded by the barge crane to the loading platform. A forklift placed a container aboard each trailer which the drove onto the awaiting causeway

ferry. On completion of loading, the containers and trucks were dogged, the ferry unhooked from the loading platform and propelled to the beach by tugboats. The ferry was beached and towed ashore whereupon Mo-Mat fiberglass matting was rolled out on top of the sand from the causeway to a prepared hardstand of AM-2 metal matting and On-Fast fiberglass matting. These surfaces insured trafficability. Ashore, the trucks were unloaded by mobile crane. Empty tractor-trailers wainting on the beach boarded the causeway ferry as soon as the loaded ones were off. The ferry then returned to the ship and the process was repeated.

Motor Transport assets remained operational throughout the exercise and minor troubleshooting cleared up all problems. The tractor-trailers were not a stumbling block in any aspect of the operation and drivers were alert and responsive.

Several minor problems were encountered:

1. Tires were unable to evenly carry the weight placed on the trailers, and there was limited contact with the causeway ferry deck due to its riveted and plated surface being uneven.
2. The gradient of the causeway beach-end approaches the maximum allowable, without straining the fifth wheel groundings.
3. Two flat tires were sustained from traveling over section connector bargs protruding up and on the edges of the sections.
4. Roll out fiberglass Mo-Mat tended to ripple under the trailer wheels, sometimes to the point of rolling it up and crushing it. Anchoring alleviated this.

Valuable information determined from the operation included the following:

1. Tractor-trailers can be driven on heaving causeway sections without great difficulty. Backing for short distances is feasible and for long distances is possible.
2. Tractor-trailers can be loaded and haul 10 and 20 ton payload containers over short distances with no apparent difficulty. This includes negotiating a 28% beach gradient.
3. Tractor-trailers can operate on prepared synthetic surfaces for a limited duration without extensively damaging them or getting stuck. Diesel fuel does not damage these surfaces.

In summary, if other critical factors are within operating parameters for ocean operations of this type, tractor-trailers can be effectively employed to aid in off loading containerized cargo.

Summary of Comments

Problems Encountered During Import Phase

*<u>Problem</u>: The forklift "pockets" in containers were not large enough for full insertion of forklift blades. This caused considerable delay in handling containers. It is also an unsafe method of operation.

<u>Recommendation</u>: That the thickness of the forklift blades be subh that full insertion of the blades into the container is possible. This will insure ease in handling containers and reduce the safety hazard. Also, the possibility of loading containers directly onto the trucks should be investigated. This could require special equipment.

<u>Problem</u>: The rear wheels of the forklift cleared the deck while hoisting the 20 container.

<u>Recommendation</u>: That the forklift designated to be used in this type operation be capable of handling maximum loads to be off loaded.

<u>Action Taken</u>: The additional 20 ton containers were not unloaded nor were they scheduled for unloading during Phase II (the open sea phase) of the test.

*<u>Problem</u>: Due to electrical difficulty the power taglines, used to control load while hoisting, were 50% disabled.

<u>Recommendation</u>: That a more heavy duty model be used in future tests. There is a definite need for power taglines.

*<u>Problem</u>: The bolts protruding from 6x15 causeway platform angle assembly can cause damage to containers.

<u>Recommendation</u>: That the protruding bolts be removed from causeway platform in that area utilized for initially placing the loaded containers and that the necessary structural strength for the platform be obtained through appropriate welding.

<u>Action Taken</u>: Plywood was laid on both sides of protruding bolts as a temporary solution.

*Problem: The excessive length of tending lines on the containers did not give the line handlers continuous positive control of loads. In addition, the lines fouled on deck of ship and barge crane.

Recommendation: That the lines used for steadying the containers be only long enough for positive control.

Problem: As the truck/trailer carrying a 20 ton load left the causeway at a 45 degree angle to the ramp, the positive stop of the fifth wheel hit the causeway.

Recommendation: That the actual limiting or positive stop for the truck/trailer be checked out to determine the transition restrictions.

*Problem: The deck of 6x15 causeway platform was distorted as a result of the heavy loads.

Recommendation: That the platform used during this type of operation be sufficiently reinforced to prevent distortion and sagging of deck plating.

NOTE: Items proceeded by an asterisk (*) were also prevalent during the open sea phase. They are not repeated in the open sea comments.

Summary of Comments

Problems Encountered During Open Sea Phase

Problem: Public Works 100 ton floating crane (YD 193) was improperly secured to the ship causing the crane to surge excessively under prevailing sea state conditions. This caused damage to the ship's hull and cancellation of the operation for the day.

Recommendation: That lines of sufficient size, preferably 10 ch nylon, be used for an operation of this magnitude to apply the needed strain for holding the crane in proper position and alleviating most of the undesirable surging. The head and stern lines must be at least 10 inch nylon vice the 8 inch used. Camels between ship and crane must be at least 4 to 6 feet wide for proper separation and adequate fendering on station as required.

Action Taken: PHIBCB 1 personnel prepared and submitted, to the Commanding Officer, USS RACINE for his approval, a sketch of a recommended system for properly mooring the crane to the ship, complete with fendering and camels, whoch could be used for the remainder of the operation. The mooring arrangement had been discussed with PWC representatives prior to submitting the proposed sketch to the RACINE. The use of this system significantly reduced the surging.

Problem: Nylon taglines used to control seinging of main purchase hook were not tended. Lines were secured to cleats on the crane boom with excessive slack which allowed the hook to swing freely. This is a potential serious safety hazard.

Recommendation: That lines be led to a source of power or tended properly by hand.

Problem: No camel was supplied for use between 6x15 causeway platform and crane causing lines to chafe and eventually part.

Recommendation: That cameling and fenders be used between the causeway platform and crane.

Action Taken: Lines were replaced and additional lines used.

Problem: The bitts and cleats installed on 6x15 causeway platform broke loose during this exercise. This caused a serious safety hazard as the bitts and cleats sailed through the air under the strain of the applied forces. Fortunately, no one was hurt.

Recommendation: That the installed bitts and cleats be reinforced to withstand the tremendous forces encountered. PHIBCB 1's use of shock absorbers helped tremendously in absorbing the constant shock placed on lines as the platform surged.

Action Taken: Wire straps were passed around platform angle assembly and shackled to securing lines. The following day shock absorbers capable of 20 ton compression were used between the wire straps and securing lines.

Problem: Some end pontoon cans on causeway ferry sections did not have welded "A" plates on the facing of each can. This condition existed on those causeway sections which had been assembled several years ago. In addition, numerous bolts worked loose and cracked welds were evident.

Recommendation: That "A" plates be welded on the facing between each end pontoon can on these older sections. As noted some of the sections were originally assembled without these plates. These plates add considerably to the overall strength of the end pontoon cans.

Action Taken: Causeway sections were kept under continuous observation during remainder of operation for any further damage.

Problem: The 3/4 inch chain used to secure trucks to causeway sections could not be "cinched-up" properly. However, the trucks did not move after secured in place but that possibility is ever-present under the conditions noted.

Recommendation: That Peck and Hale or aviation type grips be used for faster and more secure method of securing trucks to causeway to prevent the possibility of the trucks becoming loose.

Problem: The three section causeway pier (no shore end) were unable to marry to end of an eight section causeway pier due to excessive swell/surf conditions.

Recommendation: That additional causeway sections be added to the pier to place the end of the pier further outside the surf line. The sea swells were of considerable height during this phase of the operations and possibily a longer pier could have permitted operations in an area of reduced swelling.

Problem: The Mo-Mat used between causeway and landing area curled up at times during transit of trucks halting the operation temporarily.

Recommendation: That Mo-Mat be staked down at corners and possibly every ten feet along outboard edge.

Action Taken: Trucks were backed down to permit the relaying of the Mo-Mat.

Problem: The 6x15 causeway platform was not wide enough (44 feet wide) to maneuver forklift with ease.

Recommendation: That the causeway platform be constructed to the equivalent size of an 8x15 or a 9x15 pontoon can causeway section to allow sufficient room to maneuver. The 9x15 pontoon can causeway section would provide a platform width of approximately 66 feet.

Problem: The Public Works YD crane stoved a hole in the ship two foot square by 10 feet above waterline.

Recommendation: That, as previously suggested, a camel four to six feet wise be used between the ship and crane to minimize the impact on the ship.

Action Taken: Additional fenders were placed between crane and ship.

Problem: Use of the YD crane necessitated a shift from the 15 ton high speed purchase to the slow speed 85 ton main purchase for hoisting the 20 ton containers and those 10 ton loads positioned close to the ship's inboard rail.

Recommendation: That the crane used for this type operation have a high speed rigged purchase capable of handling 20 ton loads. Capability of hoisting containers close to the ship's inboard rail could have been overcome by using a camel of sufficient width between the ship and the crane.

DISTRIBUTION LIST

SNDL Code	No. of Activities	Total Copies	
–	1	2	Defense Documentation Center
FKAIC	1	10	Naval Facilities Engineering Command
–	27	44	NCEL Special Distribution list for personnel interested in Amphibious and Advanced Base Technology

Unclassified
Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) Naval Civil Engineering Laboratory Port Hueneme, California 93043	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP

3. REPORT TITLE

OSDOC II ENGINEERING TESTS - CORONADO

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Not final; 1 Sep 1971 - 31 May 1972

5. AUTHOR(S) (First name, middle initial, last name)

Richard C. Towne, James J. Traffalis, Duane A. Davis, Don B. Jones, Billie R. Karrh and Harry S. Zwibel

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
December 1972	175	2

8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S)
b. PROJECT NO. YF 38.536.005.01.010	TN-1258
c.	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)
d.	

10. DISTRIBUTION STATEMENT

Distribution limited to U. S. Government agencies only; test and evaluation; December 1972. Other requests for this document must be referred to the Naval Civil Engineering Laboratory.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	Naval Facilities Engineering Command Washington, D. C.

13. ABSTRACT

The Coronado engineering tests were conducted for purposes of evaluating the equipment capabilities and limitations of the NCEL concept. This concept evaluation included off loading 8' x 8' x 20' containers from a simulated non-self-sustaining containership and transporting the containers ship-to-shore in a roll-off mode via a pontoon causeway ferry shuttle, and across hardened beaches to a stabilized storage area. Available inventory equipment and techniques were used in these tests, such as a Navy floating YD-type crane, standard NL pontoons, Marine Corps truck/trailers, and Mo-Mat and On-Fast beach hardening. The tests were conducted in two phases: first, in the San Diego Harbor to familiarize the operators with the concept and procedures and second, in the open sea to evaluate the equipment concept. The results of the evaluation demonstrated the feasibility of the concept and the ability of the available inventory equipments to off load containers from ship-to-shore in wave/swell conditions in excess of original estimates for these equipments. Also apparent was the ability of the equipment operators to perform the concept functions with a minimum of special training and guidance beyond their normal training. The concept of a floating crane/causeway ferry shuttle is recommended for the joint service OSDOC II exercise.

Unclassified

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Containerized cargo						
Ship-to-shore						
Cargo ships						
Handling equipment						
Pontoon causeways						
Evaluation						
Field tests						

DD FORM 1 NOV 65 1473 (BACK)

PAGE 2)

Unclassified

Security Classification